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## EDITORIAL

## GINGER AND TURMERIC

LOCAL varieties of ginger have been grown for many years in the Yatinuwara Division of the Kandy District, but the quality and yield of the crop has gradually been deteriorating owing to lack of proper cultivation and manuring. More recently a few varieties of imported Indian ginger have been grown in the Kandy and Colombo Districts.

During the last two years or so the Department of Agriculture has devoted an increasing amount of attention to ginger, with two main objects in view, first of all, to increase the yield and quality of the better local and Indian varieties, and, more recently, to evolve an easy and satisfactory method of drying these locally grown gingers. In this number some information is given regarding the progress which has been made along these lines.

With the main object of securing an improved variety a Ginger Growers' Association was formed in Yatinuwara in 1931 and a small trial ground was opened at Siyambalagoda where preliminary manurial and varietal trials were carried out by the Department during 1932. The results of these manurial trials are given in the first article, and indicate (1) that the application of sulphate of potash alone and of a complete mixture has produced definitely significant increases in yield in local varieties of ginger; (2) that the quality of the ginger was improved, especially in the potash plots; and (3) that increased profits can be obtained from the use of these manures.

A new series of manurial trials is being started at Giragama, near Peradeniya, with two varieties of ginger, namely, the best local ginger obtained from the varietal trials and an imported

Cochin variety, locally known as Nugegoda ginger, since it has been grown there fairly extensively within recent years. In these trials all factors in connexion with manuring and cultivation will be tested on modern lines of field experimentation.

In order to ascertain the method of curing most suitable for the different varieties of locally grown ginger, some curing experiments were carried out at Ranawana, near Peradeniya. These experiments, detailed in the second article, have indicated that the Nugegoda ginger is the most suitable, both for curing whole and for grinding. The Local Indian is next best, but has a high fibre content, while the purely local ginger dries poorly, but is quite good for grinding. It is considered by the writer of the article that ginger curing by the ordinary method is essentially a small-holders' industry and that, even at present prices, it should prove not unremunerative. Co-operative curing would appear to be essential when the sulphur process is employed and certainly desirable under the ordinary method of curing.

A number of trials and demonstrations in ginger curing have been carried out in the Katugastota District by the Agricultural Instructor and further attention is being given towards extending the cultivation of the varieties most suitable for curing.

There are indications that the samples of dry ginger recently produced locally are quite up to the standard of the best imported Indian dry ginger. There seems to be no reason why the ginger requirements of the Island should not be met in time by local production, provided that quality rather than quantity is aimed at. The possibility of establishing an export industry is being kept in view.

As regards turmeric, this is a crop which can be cultivated more extensively with advantage in order to replace the imported article gradually. Trials carried out by the Department in the Katugastota District have shown that locally grown turmeric compares favourably with the best imported article, and that when properly cured by a simple process* it fetches the same prices locally as imported Indian turmeric. The note on turmeric published in the current number indicates that recent progress which has been made by the Department in extending the cultivation of this crop by the villager.

* Molegode, W.—Turmeric, Its Cultivation and Preparation in the Kandy District. —*The Tropical Agriculturist*, LXXIX, No. 5, November, 1932, pp. 271-273.

# A GINGER MANURIAL EXPERIMENT

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GINGER is grown fairly extensively in the Yatinuwara district in the neighbourhood of Kandy, but the average yields obtained have not been high. With a view to determining whether these could be improved by the application of fertilisers, a manurial experiment was started at Siyambalagoda in this district, about 5 miles from Peradeniya. An area of about 1/30th of an acre was utilised for the experiment. The soil is a ferruginous gravelly loam, lacking organic matter and slightly acidic in reaction.

## DESIGN OF EXPERIMENT

The area was divided into four blocks, and each block into five plots, one for each treatment. The positions of the treatments in the blocks were chosen at random. Drains of about a foot broad separated the plots from one another. Each plot was $10\frac{1}{2}$ ft. long by $5\frac{1}{2}$ ft. broad and was 1/725th of an acre in extent. The details of the treatments are shown below:

| Treatment | Quantity of fertilising constituent per acre | Nature of fertiliser and amount per acre | Remarks |
|---|---|---|---|
| A. Nitrogen | 108 lb. nitrogen | Nitrate of soda at rate of 720 lb. per acre | Half the quantity applied at planting and half two and half months after planting |
| B. Potash | 115·2 lb. potash | Sulphate of potash at rate of 240 lb. per acre | Applied two weeks before planting |
| C. Phosphoric acid | 129·6 lb. phosphoric acid | Superphosphate at rate of 720 lb. per acre | Do. |
| D. Complete mixture | 108 lb. nitrogen<br>115·2 lb. potash<br>129·6 lb. phosphoric acid | 720 lb. nitrate of soda<br>720 lb. superphosphate<br>240 lb. sulphate of potash | The fertilisers were applied as on their respective plots |
| E. Control | —— | —— | Treated culturally as the others |

The plan of the experiment with the yield data is shown in diagram below:

| Block 1 | | | | | Block 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| C | E | A | D | B | D | B | A | E | C |
| 22·7 | 15·1 | 10·5 | 23·6 | 15·8 | 18·2 | 11·4 | 10·1 | 9·3 | 10·3 |
| B | E | A | C | D | A | D | C | B | E |
| 22·9 | 26·5 | 21·3 | 27·4 | 33·5 | 14·0 | 32·4 | 23·1 | 11·5 | 9·7 |
| Block 4 | | | | | Block 3 | | | | |

Slope of land

←

## PLANTING DETAILS

The area was mamoty ploughed twice at different intervals. At the second ploughing two weeks before planting, which latter was carried out on the 19th of April 1932 at the rate of 3 lb. per plot or 2,135 lb. per acre, the whole area was limed at the rate of 1 ton per acre. Owing to an unforeseen shortage of seed ginger, three blocks were planted up with seed from Hindagala and the other block (No. 2 in the diagram) with ginger from Siyambalagoda. Although the yield figures of this block are of a different order from those of the rest, they have been included in the statistical examination of the data. The ginger was planted in the plots about 1 ft. 6 ins. apart. The whole area was periodically mulched and kept clean weeded, the weeds being allowed to dry on the respective plots. Harvesting was carried out on the 25th January 1933, just over nine months from the time of planting. Each plot was separately harvested, the lots separately washed in water and then carefully weighed.

## YIELD DATA

The yield figures of the plots in pounds of green ginger are shown in the diagram above, the letters indicating the treatments.

The results are summarised in table I below.

**Table I**

| Treatments | Lb. per plot. Block 1 | Block 2 | Block 3 | Block 4 | Totals of Treatments | Mean |
|---|---|---|---|---|---|---|
| A. Nitrate of soda | 10·5 | 10·1 | 14·0 | 21·3 | 55·9 | 14·0 |
| B. Superphosphate | 15·8 | 11·4 | 11·5 | 22·9 | 61·6 | 15·4 |
| C. Sulphate of potash | 22·8 | 10·3 | 23·1 | 27·4 | 83·6 | 20·9 |
| D. Complete mixture | 23·6 | 18·2 | 32·4 | 33·5 | 107·7 | 26·9 |
| E. Control | 15·1 | 9·3 | 9·7 | 26·5 | 60·6 | 15·2 |
| Totals of Blocks | 87·8 | 59·3 | 90·7 | 131·6 | 369·4 | — |
| Mean | 17·6 | 11·9 | 18·1 | 26·3 | | |

General Mean 18·47

A glance at the table will show that there is a marked variation in the mean yields of raw ginger as a result of the manurial treatments, the range being from 14·0 to 26·9 lb. per plot. It will also be noted that the averages of the block yields also vary widely viz. from 11·9 to 26·3 lb. per plot. There will also be observed a definite fertility gradient down the slope of the land. Thus the average of block **4** is higher than that of block **3** and that of block **1** is higher than that of block **2.** The poor yield average of the latter block is also probably due to the different jât of seed sown in this block. These variations in block and treatment yields are eliminated in the method of estimation of the error of the experiment by the analysis of variance.

## STATISTICAL EXAMINATION OF DATA

The analysis of variance is shown in table II below:

**Table II**

*Analysis of Variance*

| Due to | Degrees of freedom | Sum of squares | Mean square | $\frac{1}{2}$ ($\log_e$) Mean square | Standard error |
|---|---|---|---|---|---|
| Treatments | 4 | 472·18 | 118·04 | 1·2342 | |
| Blocks | 3 | 531·26 | 177·09 | | |
| Error | 12 | 153·3 | 12·77 | ·1224 | 3·57 |
| Total | 19 | 1156·74 | | | |

The application of the **z** test shows that as this characteristic calculated from the data (1·1118) is higher than that required for significance (·5907), the differences in treatments are definitely significant.

The standard error of a single plot is 3·57 lb. and of the difference in means between the plots 2·53 lb. For a probability of 100 to 1 (P = ·01) that the difference between any two means is not due to chance this difference must exceed 7·72 lb. or 41·8 per cent. of the mean. For a probability of 20 to 1 (P = ·05) the difference must exceed 5·51 lb. or 29·8 per cent. of the mean. The mean data obtained are summarised in table III below.

## Table III

*Yields of Green Ginger*

| Treatment | | Mean yield per plot lb. | % | Tons per acre |
|---|---|---|---|---|
| A. Nitrate of Soda | | 13·98 | 75·7 | 4·53 |
| B. Superphosphate | | 15·40 | 83·4 | 4·98 |
| C. Sulphate of Potash | | 20·90 | 113·2 | 6·77 |
| D. Complete mixture | | 26·93 | 145·8 | 8·72 |
| E. Control | | 15·15 | 82·0 | 4·90 |
| Mean | | 18·47 | 100 | 5·98 |
| Standard Error of Mean | | 1·79 | 9·7 | ·58 |
| Significant Difference between Means | P = ·01 | 7·72 | 41·8 | 2·5 |
| | P = ·05 | 5·51 | 29·8 | 1·78 |

These yields are graphically represented in Plate I. Plate II is a photograph of the ginger actually obtained from the different plots.

An examination of the data would show that the probability is greater than 20 to 1 that sulphate of potash and greater than 100 to 1 that the complete mixture produces definitely significant yield increases over the controls. The complete mixture produces significantly higher yields than sulphate of potash alone with a probability of 20 to 1 that this is not due to chance. The effects of nitrate of soda and superphosphate alone are insignificant. The dominant fertiliser for ginger would therefore appear to be potash, but a balanced fertiliser mixture with a sufficiency of potash is more advantageous, as the data obtained from this experiment would indicate.

The average yield of ginger from the control plots is 4·9 tons per acre or over fivefold, of the potash plots 6·8 tons per acre or over sevenfold, and of the complete mixture plots as much as 8·7 tons per acre or over ninefold. The increases of the latter over the controls are over 40 per cent. and 80 per cent. respectively. Even the unmanured plot yields compare very favourably with those obtained in other ginger producing countries, and may probably be the result of liming. The effect of lime on yield is one of the points to be tested out in the comprehensive manurial trials to be carried out at Giragama in the Kadugannawa district.

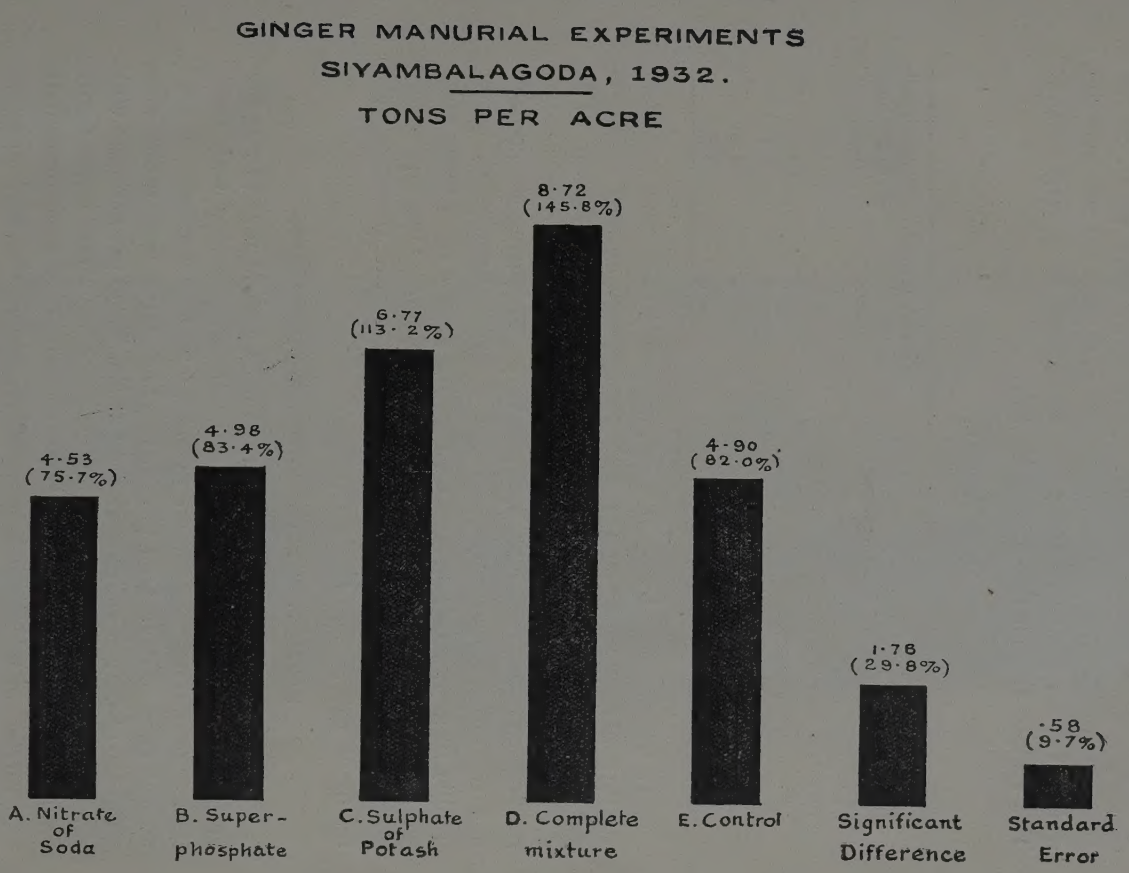


Plate I. Graph showing average yields of green ginger obtained by different manurial treatments.

## SECONDARY EFFECTS OF MANURING

In order to determine the reason for the increased yields of ginger as a result of manuring, records were made of the average number of hands of ginger per plot, of the average weight of ten hands and the average length of a single hand. The results are set down in table IV.

Table IV

| Treatment | Average number of hands per plot | Average weight of 10 hands Ounces | Average length of single hand Inches |
|---|---|---|---|
| A. Nitrate of soda | 189 | 11·8 | 4·5 |
| B. Superphosphate | 213 | 11·0 | 4·4 |
| C. Sulphate of potash | 242 | 13·8 | 4·4 |
| D. Complete mixture | 258 | 16·7 | 4·4 |
| E. Control | 185 | 13·0 | 4·0 |

It will be noted that the sulphate of potash and complete mixture plots both have (1) a larger average number of hands per plot and (2) hands of greater weight than the others. The average length of a single hand, except perhaps in the case of the control plots, does not appear to vary. Manuring with potash has therefore apparently produced a larger number of better quality of ginger rhizomes. Further the ginger from these plots has dried better than that from the other plots. This is probably due to an increase in the starch content of the rhizomes as a result of the potash manuring.

## ECONOMICS OF GINGER MANURING

In table V below will be seen the increased nett profits per acre that could be secured as a result of manuring with fertilisers containing potash, on the basis that raw ginger is sold at the rate of Rs. 1·50 per cwt. The extra nett profit with sulphate of potash alone works out at Rs. 30·00 per acre and with the complete mixture at Rs. 40·00 per acre. The latter figure would have been higher if lesser quantities of superphosphate and nitrate of soda had been applied, and in the new manurial experiment the quantities of these fertilisers are to be reduced to that of the sulphate of potash, with a consequent reduction of expenditure on the fertiliser of over Rs. 30·00 per acre.

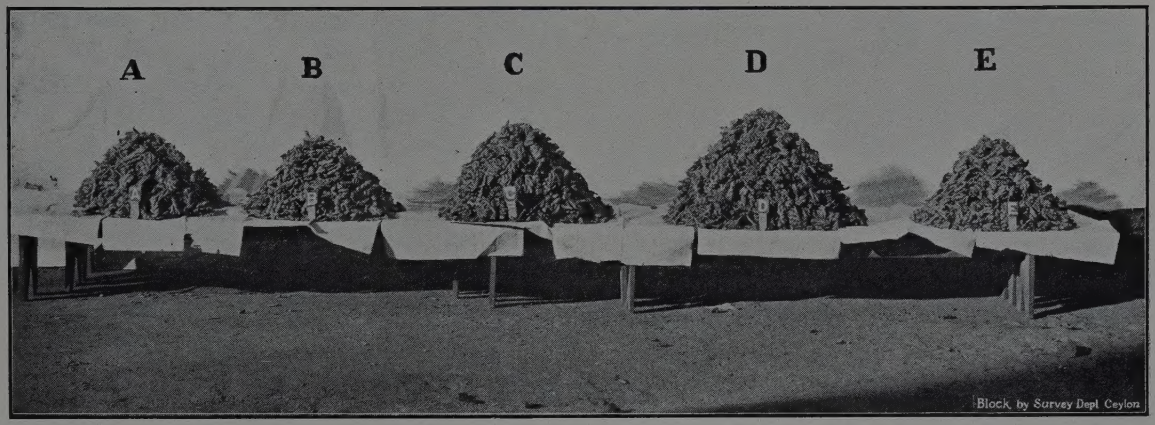


Plate II. Actual amounts of ginger obtained by different manurial treatments

Table V

| Increases over control | Tons per acre of green ginger | Amounts of fertiliser per acre | Cost of fertiliser including freight | Cost of application | Value of ginger @ Rs. 1·50 per cwt. | Nett profit |
|---|---|---|---|---|---|---|
| | | | Rs. | Rs. | Rs. | Rs. |
| 1. Sulphate of potash | 1·87 | 240 lb. | 21·00 | 5·00 | 56·00 | 30·00 |
| 2. Complete mixture | 3·82 | 240 lb. sulphate<br>720 lb. nitrate of soda<br>720 lb. superphosphate | 69·00 | 5·00 | 114·00 | 40·00 |

## CONCLUSION

A sample manurial trial with ginger carried out on four randomised blocks at Siyambalagoda in the Yatinuwara district, showed that definitely significant yield increases are obtained by manuring with sulphate of potash and a complete mixture. The average increase was nearly 80 per cent. over the control in the case of the latter and nearly 40 per cent. with the former. These increases are statistically significant, the probability being over 20 to 1 that the sulphate of potash and over 100 to 1 that the complete mixture are responsible for the increased yields. Nitrate of soda and superphosphate do not significantly affect the yields in any way. The increased profits over those of the controls as a result of these manurial treatments amount on the average to about Rs. 30·00 per acre from the potash plots and Rs. 40·00 from the complete mixture plots.

## ACKNOWLEDGMENT

Our thanks are due to Mr. L. B. Hindagala, President, Village Tribunal, Siyambalagoda for having made the land for this experiment available and to Mr. W. Molegode, Agricultural Instructor, Katugastota, for having carried out all the agricultural operations involved in it.

# EXPERIENCES IN GINGER CURING

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## INTRODUCTION

GINGER is grown fairly extensively in certain districts in the Central and Western Provinces, but almost the entire crop has been sold, up to now, as raw ginger. With the marked fall in price of this commodity, however, the question of the preparation of dry ginger became of importance and was seriously taken up by the Department. Ceylon ginger has the reputation of drying badly, but whether this was due to faulty curing methods or to its poor quality was not known. Our experience has indicated that while both factors are responsible for the trouble, the inherently poor quality of the local ginger is the primary cause. Local ginger has undoubtedly deteriorated in quality owing to improper methods of cultivation, neglect of manuring, etc. That by suitable artificial manuring the quality of a sample of locally grown ginger has been markedly improved, is evidence in point. Local ginger is inferior to the Indian varieties in size and thickness of hand, fracture and internal colour, and has generally a higher fibre content than the latter. In addition to the purely local variety, ginger imported from India within comparatively recent times is grown to some extent locally. In the Central Province, Calicut ginger is apparently the variety that has been introduced and its cultivation is extending. This is a variety with large, thick hands but like the local ginger it is very fibrous. It will be referred to in this paper as Local Indian ginger. In the Western Province (Nugegoda area) Cochin ginger has been fairly widely cultivated. This ginger (which will be referred to as Nugegoda ginger) though not as plump as the Calicut variety, has a very good fracture and low fibre content. Unlike the local ginger the good hands of the Nugegoda ginger are, in cross section, yellowish in colour and opaque, whereas the former are much less yellowish in colour

and translucent. Calicut ginger is intermediate between the two in these respects. In all three varieties, hands showing a bluish colour in cross section are not infrequently found. These give dry products inferior to the corresponding yellow hands.

## GINGER CURING METHODS

The primary object of the curing investigations undertaken was to determine the method most suitable for the varieties of locally grown ginger. There are two known methods of drying ginger: (1) ordinary curing (2) sulphur-lime curing. The former is adopted in all ginger growing countries, but the second is practised only in certain districts in India.

The investigations were carried out at Ranawana, about two miles from Peradeniya, through the courtesy and with the co-operation of Mr. A. B. Wegodapola. No less than a ton of raw ginger was cured by the lime-sulphur process. Some work was however done on the ordinary method of curing and the experiences with this method are also dealt with in this paper. A large quantity of ginger was however cured by the ordinary process by Mr. W. Molegode, Agricultural Instructor, Katugastota.

## ORDINARY CURING

Ordinary curing was carried out as follows: The ginger was soaked in water overnight, peeled by hand with bamboo knives, washed again in water and then left to dry in the sun on bamboo barbecues. Frequent turning of the ginger when drying was found necessary. When completely dry, (this took about 6 or 7 days when strong sunshine was experienced) the ginger was again washed in water and re-dried in the sun. This practice was avoided if weather conditions were not satisfactory. Good sunshine is essential for ginger drying. Rainy or cloudy weather results in the product becoming mildewed and spotted and giving a musty odour and flavour. Ginger should be thoroughly well dried before it is bagged.

The disadvantage of the ordinary curing process is that with the local ginger it gives a thin, stringy, shrivelled dry product with poor fracture. Samples of this ginger from plots manured with sulphate of potash were however superior in many respects to unmanured ginger. This points to the poor quality being due to a deficiency of fertilising constituents in our ginger soils.

## MODIFICATIONS OF THE ORDINARY CURING METHOD

Numerous modifications of this process have been adopted at various places. In certain parts of India the ginger is soaked in water for as long as two days. In Jamaica the hands are placed in water immediately they are uprooted, for, should the ginger be dried with the soil and roots adhering to it, the product will not be white.

Peeling in Gujarat is carried out either by scraping with a piece of earthenware shell or by rubbing the rhizomes on a coir string bedstead. In Jamaica ginger peeling is considered an art. The expert peels between the fingers of the hand and the less experienced peelers the other portions. Narrow bladed knives are used in peeling. Our experience in regard to peeling is that a woman can ordinarily peel about 28 lb. or a quarter cwt. of raw ginger a day. If the ginger is clean peeled, only about 14 lb. or one-eighth cwt. can be done a day. Peeling is therefore a costly operation. At the rate of -·30 cts. per woman a day, ordinary peeling costs in curing one cwt. of dry ginger will amount to Rs. 7·20, six cwt. of raw ginger being required, on the average, for one cwt. of the dry product. For clean peeling this cost would be doubled. In certain parts of S. India no peeling is done, but after being well soaked the ginger is tread under foot in the washing tanks. This considerably lowers the cost of production.

The peeled product should be immediately put into a tank of clean water and thoroughly washed with frequent changes of water. This has been found very necessary if a light-coloured dry product is to be obtained. On exposure to air the peeled rhizomes darken considerably in colour and this stain persists. Where ginger is being cured, a good source of water supply should therefore be near at hand.

In order to obtain a whiter product peeled ginger, after washing, is soaked for some hours in lime water and then allowed to dry. The lime may then be washed off, if required. Liming improves the keeping quality of the ginger.

Drying is carried out in Jamaica on cement barbecues, and in certain places in India, on mats and gunny bags on the ground. The latter practice should be avoided if the ground is wet or damp. In certain districts in India after the ginger is well dried, it is carefully rubbed by hand on a coarse gunny bag and then allowed to dry again. This is said to improve the white colour of the dry product.

*Photo.* *L. S. Bertus*

Plate III. Type of shed used for sulphuring ginger

## SULPHUR CURING

In sulphur curing, the green ginger was treated as in the ordinary method, but after peeling it was placed in a tank of lime of the consistency of whitewash for a period of about two hours, during which time it was stirred once or twice. The ginger was then put into wicker or coir-bottomed baskets and placed on bamboo racks or shelves in a closed chamber and sulphured for 4 hours. A mud-wall room 6 ft. by 6 ft. by 6 ft. was used for this work. It had a door at one end and a hearth opening from the outside at the other. The hearth consisted of an iron pan or tray supported on a semi-circular wall about 1 ft. 6 ins. high. Sulphur was placed on the tray which was then heated from below. The quantity of sulphur used in the first instance was 7 lb. per 1,500 lb. of green ginger. The next day the ginger was placed in the sun to dry and in the evening the liming and sulphuring process repeated. 8 lb. of sulphur were used this time and the period of sulphuring was increased to twelve hours. The process was repeated a third time, the quantity of sulphur having been increased to 9 lb. and the period of exposure shortened to six hours. The product was then left to dry on the barbecue and when well-dried, the lime was washed off and the rhizomes left to dry again thoroughly, Plates III, IV, and V will give an idea of the type of curing shed, washing and liming tank, and barbecue used in the investigations. The dry ginger so obtained is a comparatively plump, almost white-coloured hand with a good fracture. It is much less susceptible to mould and insect attack than ordinary dried ginger. The disadvantage of the method, apart from the small extra cost and the trouble necessary, is that the product so cured is not saleable in all countries owing to the sulphur dioxide it contains.

## INVESTIGATIONS ON THE SULPHUR CURING PROCESS

During the course of the curing, several experiments were made to ascertain how far variations in quality and quantity of the raw materials and modifications of the process affected the quality of the final product. The results of these are detailed below.

*Effect of Liming.*—The optimum quantity of lime required was found to be about a bushel (50 lb.) of slaked lime for 3 cwt. of raw ginger. The quality of the lime makes a difference in the appearance of the final product. The purer the lime, the better the result. Unslaked lime is best used.

*Variations in the Sulphuring Process and their Effects on the Quality of Dry Ginger.*—The effects on the appearance of the dry product of a reduction of the number of limings and sulphurings from three or two were not very marked. The thrice-limed and sulphured product is superior in appearance to the twice-treated product, but there was no difference between the two in fracture and percentage out-turns of first and second grade ginger. In the case of the two-sulphuring process, the periods of exposure in the sulphur chamber were four and twelve hours respectively. The sulphur dioxide content of the twice-sulphured product is, however, much higher than of the thrice-sulphured product. Thus a sample of the latter contained 2006·4 p.p.m. of sulphur dioxide as against 1116·9 p.p.m. in a sample of the former. The sulphur dioxide content was determined by the Monier-Williams method.

The effects of a reduction of the quantities of sulphur from 7, 8 and 9 lb. per 1,500 lb. of green ginger to 4, 5 and 6 lb. respectively were also studied. It was found that while the final products in the former case were superior in external colour and plumpness to those in the latter, there was no difference in fracture and internal appearance. The sulphur dioxide content of the samples treated with smaller quantities of sulphur was however smaller viz: 794·7 p.p.m. as against 1154 p.p.m. in those cured with the larger quantities of this element.

The effect of sulphuring alone without liming was also studied. With Nugegoda ginger a very good final product almost white in colour was obtained by sulphuring the peeled, thoroughly washed raw ginger for four hours at the rate of 7 lb. of sulphur for 1,500 lb. of raw ginger. The product after drying was washed in the morning and left thoroughly to dry in the sun. The sulphur dioxide content of this sample was found to be as low as 263·5 p.p.m. The great possibilities of this process are indicated.

*Effect of Variety and Age of Ginger on the Final Product.*—The out-turns of dry ginger were as follows:

| | Total | 1st quality | 2nd quality |
|---|---|---|---|
| | % | % | % |
| Nugegoda | 16·2 | 8·1 | 8·1 |
| Local Indian | 17·6 | 8·2 | 9·4 |
| Local | 15·8 | 8·2 | 7·6 |
| *Average* | *16·5* | *8·2* | *8·3* |

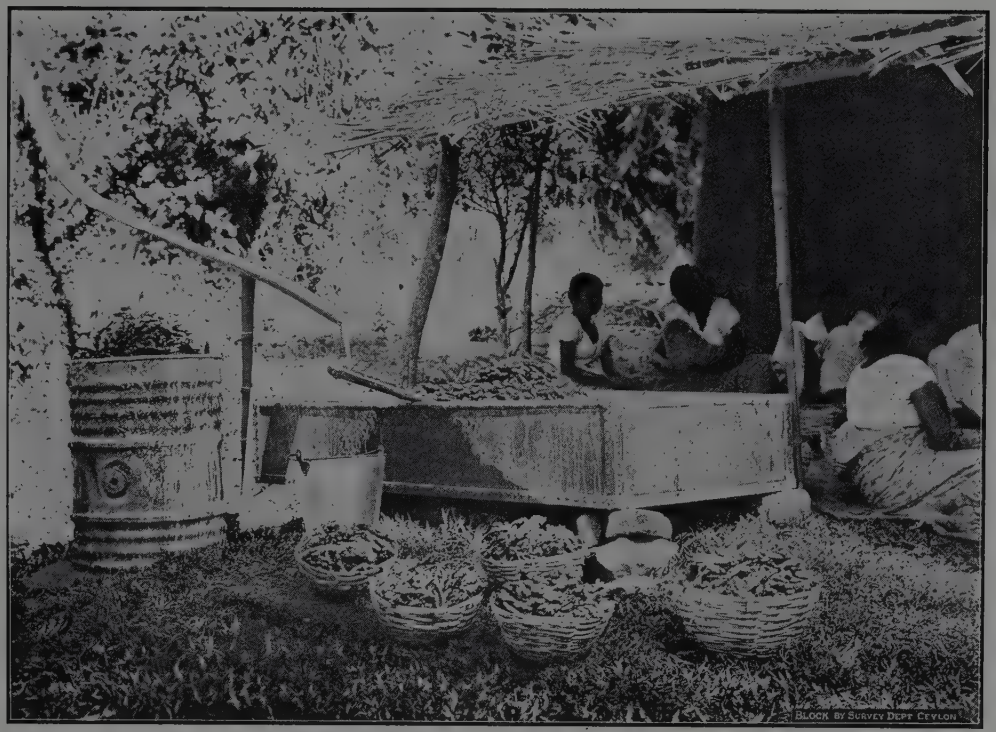


*Photo.* *L. S. Bertus*

Plate IV. The washing and liming tanks. Peeling in process is also shown

*Photo.* *L. S. Bertus*

Plate V. Bamboo barbecues used in the drying process

It will be seen that in general 6 cwt. of green ginger will be required to produce one cwt. of dry ginger for each of the varieties and the proportions of first and second quality dry ginger are about equal. Grading of all varieties of dry ginger is very necessary if a scale of whole ginger is to be effected. In Jamaica four or five grades are recognised. The lower grades can be used for grinding purposes.

In regard to the quality of the samples as affected by variety our experience is that Nugegoda ginger which even in the raw state has a good, clean fracture and yellowish colour, dries best and is most useful both for curing whole and for grinding. The Local Indian is next best, but its disadvantage is its high fibre content. The local ginger makes the poorest whole dry product, but it is quite good for grinding. These observations on the drying properties of the three varieties are confirmed by the milling data. The Nugegoda ginger gave a flour out-turn of 79·2 per cent; the local ginger 78·5 per cent; and the Local Indian 75 per cent. The fibre content of the latter is highest viz. 14 per cent. and that of the Nugegoda ginger lowest—10 per cent. In contrast to these figures the unsulphured local ginger (limed) gave 62 per cent. and the unlimed 53·5 per cent. of powder. The superiority in this respect of the sulphured and limed product is therefore apparent.

The comparison of the curing qualities of first and second year (ratoon) ginger carried out on a 4 cwt. sample of Local Indian (Calicut) ginger indicated that first year ginger was superior on the whole. The percentage out-turn of dry ginger was 20 per cent. of the first year and 16 per cent. of the second year raw material. The first year sample was also superior in colour and fracture and apparently in thickness as well. Further, its proportion of first grade ginger was also higher, i.e., 50 per cent. of the total against 40 per cent. in the case of second year ginger.

An experiment was made to determine to what extent the external characteristics of raw ginger give an indication of their drying qualities. A sample of Local Indian ginger was divided into three lots according to the colour of the fractured root-stalk and appearance of skin and these lots were separately dried. They were as follows:

(a) Those hands showing a yellow or creamish fractured surface but with tough, glossy skin.

(b) Those showing the same colour as above but with soft skin—due perhaps to excessive moisture in the soil. These two grades are the equivalent of the Jamaican yellow ginger.

(c) Those with a distinctly bluish fractured surface and skin either tough or soft. This is apparently the equivalent of the Jamaican "blue" ginger.

Lots (a) and (b) gave the best results, lot (a) being superior. Most of these hands dried whitish and plump and had a good fracture. Lot (c) gave for the greater part thin, shrivelled hands, bluish-purple in colour and of poor fracture. These results are definitely encouraging and further investigation on the point should prove fruitful. Actually however, grading after drying will definitely be the more practicable procedure to adopt. What however is clear is that only sound, fully-developed rhizomes should be used for drying. Our experience is that first year rhizomes are best for drying, but second year or (ratoon) rhizomes can also be used advantageously.

## ECONOMICS OF GINGER CURING

As ginger is generallly grown in small blocks and but rarely in large extents by individual growers, it would appear that the curing of this commodity is essentially a small-holder's industry. Co-operative curing would however appear to be necessary when the sulphur process and desirable when the ordinary curing method is employed. At the present market rates, ginger curing for the local market would not appear to be profitable except as a cottage industry. There would however appear to be prospects for a market abroad for a good quality local product. Reckoning on a ruling price of raw ginger of Rs. 1·25 per cwt. for large quantities, the gross return to a grower from 6 cwt. of raw ginger, the amount required for 1 cwt. of the dry product, would be Rs. 7·50. Curing costs per cwt. of dry ginger, if ordinary peeling is done, and if paid labour is employed, would be Rs. 7·50 by the ordinary process and Rs. 10·50 by the sulphur-curing process, Rs. 3·00 being reckoned as the cost of sulphuring and liming. It would thus be seen that for an economic return on curing under these circumstances, the price of the first quality dry ginger locally should exceed Rs. 15·00 per cwt. If however treading by foot is done instead of peeling, the cost of curing should not exceed Rs. 3·50 and Rs. 6·50 respectively and prices in excess of Rs. 11·00 should

give economic returns. The great advantage of curing is that when there is no market for raw ginger owing to an over supply, as is the case at present, it would be a means of preserving the crop for at least a period of a year. Where however the ginger is cured by the grower and his family, ginger curing even at the present prices, should prove not unremunerative.

## BY-PRODUCTS OF GINGER CURING

In order to determine whether the ginger peelings contained oil which would make their distillation a commercial proposition, about 150 lb. of this material were distilled. The oil yield obtained was very small (·055 per cent.) and would not in all probability pay the cost of distillation. The dried peelings might however be used for manuring or as fuel, and the ash residue, thus obtained, for manuring.

## ACKNOWLEDGMENT

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# ENTOMOLOGICAL NOTES

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## PESTS OF GARDEN PLANTS

### 1. THE ROOT-EATING ANT (DORYLUS ORIENTALIS WESTW.)

This ant belongs to a group which includes the notorious "driver ants" of Tropical Africa and America. These "driver ants" are essentially carnivorous and entomophagous, that is, in addition to being able to devour any of the larger animals which they come across in a confined or helpless condition, they also feed on any other insects which they find in the soil or elsewhere on their foraging expeditions. One of the Eastern species (*Dorylus orientalis*), which, according to Bingham [1] occurs "throughout India, Burma and Ceylon, extending to the Malay Peninsula, Borneo, Sumatra and Java", has been known for some time to have entirely different feeding habits from those of its relatives in other parts of the tropics. This species was reported some 35 years ago to be damaging potato tubers in India, but at first these ants were thought to be incapable of the injury in view of the predaceous habits of their relatives elsewhere. Then they were definitely found riddling sugarcane plants in India and their herbivorous habits were confirmed in Ceylon by Green [3] who made the following observation: "The workers of this species (determined for me by Colonel Bingham) live entirely underground and I can assert from repeated personal observation that they are most confirmed vegetarians. I found it quite impossible to grow potatoes at Pundaluoya solely on account of this insect, and they were most aggravating in their systematic attack upon the tubers of dahlias and the roots of the common sunflower (*Helianthus* sp.). In the case of the tubers they form galleries through and through the substance and in the case of roots they eat off the tender bark below the collar". Green completely satisfied himself that the *Dorylus* was really feeding upon the vegetable tissues and was not merely hunting for other insects. It may be mentioned that another species,

*Dorylus labiatus*, in India [1] is known to be partly carnivorous, attacking other ants, and partly herbivorous, feeding on potato tubers. Up to the present time, *orientalis* has not been observed locally to have carnivorous habits.

In Ceylon since 1900 this ant has been reported occasionally in some up-country and mid-country districts, but within recent years its observed and reported appearances have been much more frequent and widespread. This species has also been gradually extending its range of food plants and is now known to feed on the underground portions of a great variety of ornamental and vegetable plants, including zinnia, balsam, groundnut, potato, sweet potato, beet, carrot, radish, cabbage, knol-khol, artichoke, bean, etc. These ants have also been found attacking the roots and collars of young trees, such as potato tree (*Solanum macranthum*), *Citrus* spp., flamboyante (*Poinciana regia*), *Eucalyptus* sp., etc. In the case of plants with bulbous or tuberous roots the fleshy portions are completely riddled, while in other plants the tender portions of the roots and collar are devoured.

The Eastern species of *Dorylus* according to Bingham [1] are noteworthy for the great difference in appearance between the workers and the males and between the males and females, or queens. The *workers*, which are responsible for the damage to plants, are about one-fifth of an inch long, chestnut brown to reddish brown, with rather large rectangular heads bearing a deep furrow down the middle. The central portion of the body, mainly the thorax, is flattened and not markedly constricted as in many other ants, that is, there is no distinct "waist", while the abdomen, or hinder portion of the body, is somewhat flattened above. There are two castes of workers, one as described above, and the other much smaller and paler in colour. Both castes of workers are wingless and have no eyes, hence the local name "blind ants".

The males are nearly an inch long, winged, yellowish-brown, with well-developed simple and compound eyes, and somewhat resemble wasps; they sometimes fly to bungalow lights at night. The *female* of *orientalis* has apparently not been found in Ceylon, but that of a related species of *Dorylus* in Burma [1] is said to be more than an inch long, reddish-brown, without wings or eyes, and with a "large abdomen a little resembling that of a queen termite",

The *Dorylus* worker ants live entirely underground and, so far as is known at present, their main nests are probably situated fairly deep down. It is thought that from the main nests foraging parties go out in all directions underground to feed on the roots of the plants. It is possible, however, that in some cases small colonies may be established temporarily at the bases of certain plants. As indicated above, the workers are not known to appear above ground and their presence is usually not detected until the attacked plants begin to wilt. When disturbed they rapidly retreat into the soil again.

It may be mentioned that owners of gardens in the drier districts have reported that these ants are more troublesome in the dry weather, that is, during May to September. A possible explanation of this dry weather prevalence of the pest may be that the ants come to the well-watered gardens from drier areas in search of moisture and the more succulent food so conveniently provided for them.

## CONTROL MEASURES

When once this ant has become established in a garden it is not at all easy to get rid of. There is usually no chance of being able to exterminate the main nests, since these are probably situated deep underground and possibly at some distance from the points of attack. But it is possible, however, gradually to kill off many of the ants actually in the garden beds by the use of petrol and to make life so uncomfortable for the survivors that the plants are left alone in the early stages of growth.

*Preventive measures.*—In areas where the ants are known to be troublesome, the beds should be thoroughly treated with petrol before replanting. This fumigant can be poured in small quantities along shallow furrows made at intervals along the beds or into a number of small holes made in the soil at frequent intervals. The furrows or the holes as the case may be, should be covered over with soil immediately after treatment. Or the top few inches of soil can be removed from a portion of a bed, the exposed surface sprinkled with petrol and the soil replaced immediately; the remaining portions of the bed can then be similarly treated. One to two pints should be sufficient to treat every thirty square feet of surface, depending on the thoroughness of the treatment.

After manuring and before replanting, the beds can be treated with sawdust or wood ashes steeped overnight in a solution of any good carbolic disinfectant at the rate of two teaspoonsful to every bottle of water. This deterrent mixture can be sprinkled over the beds worked thoroughly into the top soil and left for a day or two before replanting.

*Remedial measures.*—If the pest appears for the first time in beds of growing plants and its presence is detected only after the young plants have begun to wilt and die off, then usually the general fumigation recommended above cannot be applied owing to the risk of injuring the surviving plants. All badly attacked and dying plants should be carefully removed one at a time and the holes immediately treated with petrol before the ants have had time to disperse, one or two small table-spoonsful being poured into each hole which is then forthwith plugged with damp earth. If the plants are well spaced, the furrow method of applying the petrol between the rows can be tried, or individual plants can be treated by applying the petrol in shallow circular furrows in a radius of about 6 to 9 inches from the plant. A few plants in different beds should be treated first as an experiment and if the ants are killed without injury to the plants then the remainder of the plants can be treated gradually. The impregnated sawdust of wood ashes can be applied around such plants a day or two after the petrol treatment to serve as a deterrent. If the attack is not discovered until most of the plants in a bed are dying, then the only remedy is to take out all the plants and give the bed the full treatment recommended under preventive measures before replanting.

If these *Dorylus* ants have become thoroughly established in a garden, a vigorous campaign should be launched at the beginning of each planting season or at any other time that they become troublesome. It may be a long and rather tedious struggle, but owners of gardens have found that, by adopting the above measures thoroughly and systematically whenever the ants appear, they can manage to grow vegetables and ornamental plants successfully without serious injury by this pest.

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## 2. COCKCHAFER BEETLES

Everyone is familiar with the moderate-sized, rather stout, brownish beetles which come buzzing and blundering into bungalow lights at night after the first good rains in April and May. The earlier arrivals begin to emerge from the soil about the end of March and during April, and their numbers rapidly increase throughout May and June, during the south-west monsoon rains, gradually becoming fewer in July to a few belated stragglers in August. Every now and then in certain districts there comes a "cockchafer year", during which grass lawns are killed out in patches by the root-feeding grubs and ornamental shrubs and flowering plants are tattered and torn by vast swarms of beetles which carry on their destructive work mostly at night. The beetles are known by different names in other countries, such as "May beetles" or "June beetles" in America, and "hard backs" in the West Indies. The grubs are usually known as "white grubs" in most parts of the world.

Our Ceylon cockchafers are of many different kinds and sizes, but the more important species belong to two sub-families of the very large family of beetles known as the *Scarabaeidae*. The true cockchafers are grouped under the sub-family *Melolonthinae* and include mostly dull-coloured beetles of varying shades of brown. They are active mainly at night, coming out at dusk and retiring at dawn to hide in the ground or in other sheltered places; these insects are usually attracted to lights. In the beetle stage they usually feed on the leaves of a great variety of plants and sometimes attack flowers as well, while the grubs consume grass roots or eat away the underground portions of various cultivated plants.

The members of another closely related sub-family, the *Rutelinae* include many brightly-coloured species and are sometimes also called cockchafers. Many of these are night-feeders, but some, especially the more conspicuously coloured ones, are also active during the daytime and rarely come to lights at night. Some species of this group show a distinct preference for flowers rather than leaves, while others are general feeders. Speaking generally, it may be said that the Melolonthine beetles are rather less injurious than the Ruteline beetles, since the former are not such voracious feeders as the latter nor do they attack flowers so readily. On the other hand the Melolonthine grubs are as a rule far more serious pests than the Ruteline grubs, since the

former are essentially root-feeders, while many species of the latter probably feed mainly, if not entirely, on decaying vegetable matter in the soil.

Below will be found some observations on a few of the more important species of Ceylon cockchafers grouped under the two sub-families. The notes on local distribution and feeding habits are taken mainly from our records extending over a number of years and give some indication of the type of injury caused by some of our local species and their grubs. The brief descriptions of their external appearance and approximate size are taken from pinned specimens or fresh material, whenever possible, and in the case of the *Rutelinae* are supplemented by numerous references to Arrow [1]. In the measurements of sizes, 25 millimetres (mm.) = 1 inch. It should be mentioned here that, so far as is known at present the great majority of our Ceylon cockchafers are found mainly in the southern and wetter half of the Island; therefore the term "widely distributed" means distributed throughout this range, and "low-country" means the wetter low-country districts.

## MELOLONTHINAE

*Lepidiota pinguis*.—Length, 35-40 mm.; breadth, 17-22 mm. The largest of our local cockchafers. Greyish to greyish brown. Widely distributed. Grubs attack roots of cinnamon, young rubber and tea. Beetles feed on leaves of dadap, acacia, etc.

*Holotrichia serrata*.—Length, 23-26 mm.; breadth, 12-14 mm. Deep chocolate brown. Mainly low-country. Grubs a pest of grass lawns and roots of various plants. Beetles eat leaves of canna, etc.

*Microtrichia* spp.—Length, 11-13 mm.; breadth, 6-7 mm. Dark brown. Mainly low-country. Nothing known about the the grubs. Beetles feed on canna flowers, leaves of albizzia, young rubber and various garden plants.

*Autoserica mollis*.—Length, 8·5-9·5 mm.; breadth, 5-6 mm. Stout, golden brown. Mid to low-country. Nothing known about grubs. Beetles feed on rose flowers and on albizzia and young rubber leaves.

*Apogonia rauca*.—Length, 9-11 mm.; breadth, 6-6·5 mm. Dark brown to blackish. Nothing known about grubs. Beetles attack cacao leaves.

### RUTELINAE

*Popillia discalis*.—Length, 9-11 mm.; breadth, 5-7 mm. Oval, shiny, varying from deep metallic green, blue, coppery to almost black; elytra, or wing covers, varying from deep metallic green to pale brown; white spots around the sides and end of body. Mainly up-country, but occasionally found at lower elevations. Grubs may feed on roots of grasses, etc., or on decaying vegetable matter. Beetles common on grass lawns and on garden plants, feeding on leaves and flowers.

*Mimela mundissima*.—Length, 13-16 mm.; breadth, 8-9 mm. Broadly oval, shiny, deep grass green, with a narrow yellow band around the edges of wing covers, etc. Widely distributed, but mainly up-country. Grubs attack tea roots. Beetles feed on leaves of acacia, eucalyptus, etc., and on flowers of garden plants.

*Anomala tenella*.—Length, 4·5-6 mm.; breadth, 2·5-3·5 mm. Orange yellow, suffused above with a golden green or coppery lustre. Widely distributed. Nothing known about grubs. Beetles feed on young leaves of tea, dadap, rose, etc.

*Anomala superflua*.—Length, 19-22·5 mm.; breadth, 10-11·5 mm. Yellowish brown with a black head and a fine black line around the edges of the wing covers. Widely distributed. Grubs feed on tea roots. Nothing known about feeding habits of the beetles.

*Anomala dussumieri*.—Length, 24-26 mm.; breadth, 13-15 mm. Oval, shiny, bright emerald green. Mainly low and mid-country. Grubs attack roots of cinchona. Beetles feed on cinchona leaves.

### HABITS AND LIFE-HISTORY

The complete life-cycle of any species of cockchafer has not been worked out in Ceylon, but from partial observations made on the development of several different species and from what is known of related species in India, [3], and in the Dutch East Indies [2], the habits and life-cycle of a typical cockchafer are somewhat as follows:

The *eggs* of the various species are laid singly, sometimes in the top two or three inches of soil, but sometimes deeper. They are small rather long oval and whitish when freshly laid, but gradually increase in size and become almost spherical before hatching. They vary in size according to the species. After

about ten days to about a month, according to the species, the eggs hatch into small whitish grubs with pale-brownish heads, curved bodies and three pairs of well-developed legs.

The *grubs* burrow down into the soil where they remain for several months feeding on roots of grasses and other plants. Some species breed in patna soils and attack the roots of estate crops planted in patna clearings. As indicated above, the root-feeders are mainly Melolonthine grubs. Other species of grubs, belonging mostly to the *Rutelinae*, feed on decaying matter in the soil. These various grubs usually become full-grown in about 6 to 9 months and then change into the pupa or resting stage inside earthen cells. Some species may remain dormant in the grub stage for several weeks or even months before actually becoming pupae.

The *pupal* stage is usually comparatively short, lasting only from about ten days to about one month, according to the species. Sometimes the beetles remain in their earthen cells until the rains have softened the ground sufficiently to allow them to emerge and begin breeding all over again. It is probable that most of our local species take just under one year to develop from egg to beetle, at any rate in low to mid-country districts, although it is possible that at higher elevations the life-cycle may occupy rather more than a year.

## CONTROL MEASURES

These pests can be controlled to some extent in both the beetle stage and as grubs.

*Beetles.*—Since some species are attracted to lights, it is sometimes possible to catch numbers of them by rigging a simple light-trap made by placing a windproof lantern on a brick in the middle of a pan or basin of water with a film of kerosene on the water. Light-traps are usually more successful on dark, damp still nights and need only be put out for a couple of hours after dusk. On wet nights the lamps can be protected by a rough shelter. Tests on suitable nights during April to June will indicate whether light-traps are going to be successful for the particular locality. Some species can be collected from the plants or from grass lawns in the late afternoon and early morning and dropped into tins half-full of water covered with a film of kerosene. Other species can be found on garden plants during

the day and similarly disposed of. As many beetles as possible should be trapped or collected during April to June before they lay their eggs.

*Grubs*.—These are difficult to kill in the soil, especially under grass. If certain garden beds are known to be infested year after year, the opportunity should be taken of removing as many grubs as possible whenever the beds are dug up before replanting. The petrol fumigation recommended against *Dorylus* ants is sometimes useful in killing off white grubs, although rather stronger doses are needed. Powdered naphthalene (moth balls) worked into the soil around, but not too near, the plants will act as a deterrent, or the impregnated sawdust or woodashes suggested for *Dorylus* can be used as an alternative method of keeping away the grubs.

When grass lawns are attacked in patches, sometimes watering the patches with a solution of nitrate of soda before rain should bring many of the grubs to the surface. This fertiliser can also be sprinkled over the grass before rain with similar results. It is sometimes advisable to take up badly infested patches and remove the grubs or drench the soil with petrol poured into numerous holes. If the latter method is tried, then the area should not be returfed until the next day.

Cockchafer beetles and grubs are often liable to be troublesome in gardens adjoining patna areas, since the beetles breed freely in such places and invade the gardens annually from April to June. Problems such as these involve a thorough and systematic campaign almost every year in each individual garden, since there is no practicable method of controlling these pests in patna soils nor of preventing the beetles invading cultivated areas.

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# FOOD CROPS OF THE TROPICS

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THE representatives of the Breadfruit and its relatives in Ceylon consist of the Breadfruit proper (*Artocarpus incisa*) or Rata-del S., Erapillakai T; the Jak fruit (*Artocarpus integra*) or Kos S., Pillakai T; the Johore Jak (*Artocarpus champedan*) and the wild Breadfruit (*Artocarpus nobilis*) the Bedi-or Wal Del S., Asini-pillakai T. The order to which these trees belong include many others of wide economic value such as the Fustic, Mulberry, Fig, Panama rubber, China grass and the Ganja or Indian Bhang.

## BREADFRUIT

Dealing first with the seedless form of Breadfruit proper (*Artocarpus incisa*), it is surprising that, in spite of its known qualities as a nourishing, wholesome and palatable food of much starch content, and as a plant of high food value rivalled only by the Banana or Plantain, this tree is not more commonly cultivated in Ceylon. The reason for this is doubtless due to the difficulty in propagation, since the Breadfruit is seedless and does not normally root from cuttings, and the laborious method of forcing the tree to produce root-suckers, usually by the wounding or incision of the root, has to be adopted.

The Breadfruit is a native of the Malayan Archipelago and the actual date of its introduction into Ceylon is uncertain, but is presumed to be somewhere about 1796. It is possible that the original plants received here were from the consignment collected and transported to the West Indies by the Bligh Expedition of 1792 to the Pacific Islands, or most probably it may have been introduced prior to that date by the Dutch. There is also a seed-bearing tree in the Gardens, but although of good quality it is not the equal of the seedless forms, and propagation should on principle be only from the latter.

The tree grows to a height of about 50 to 60 feet and is of a spreading nature. The fruit is roundish to ovoid in shape, muricated or reticulated, growing one to two and sometimes three together near the end of the branches, attaining an average

weight of 3 to 4 pounds each, and 8 inches long by 4 to 5 inches in diameter. The number of fruits supported by a well grown mature tree will vary from about 600 to 800, the ripening period extending over a period of several months. The tree is of very rapid growth and when once the rooted suckers have become established there are few fruit trees of its size more easily grown or more free from attack by pests and diseases.

The fruit is not eaten raw but is sliced, boiled or baked, and when boiled it resembles in texture the sweet potato and forms a wholesome, starchy, palatable vegetable. When thinly sliced and baked in the sun or in ovens, a form of biscuit is obtained which, when dried, will last from one breadfruit season until the next. These slices may be eaten baked or toasted or may be ground up into flour and cooked in various ways. A better local knowledge of this fruit and its preparation to the best advantage is very desirable, since other tropical countries utilise the fruit to much advantage and place a high value on the nutritive properties of the ripe fruit.

The cultivation of this tree can be undertaken anywhere in the moist zone from sea level up to 3,000 feet but it is not suited to the dry zone owing to its enormous leaf surface and demand for moisture consequent upon a heavy crop. Once established in its permanent site and protected from damage by trespassing cattle and such like, the tree practically takes care of itself. The greatest difficulty lies in procuring the young plants in sufficient numbers, since the fruit contains no seed and young plants (suckers) are rarely obtainable from the roots of the old trees.

It has been observed that where the roots of old trees have been injured, root-shoots or suckers are very apt to form, and a series of root experiments with root-cuttings undertaken by the late Mr. P. J. Wester in the Philippines shows that, if properly handled and made at the right time, with the employment of a suitable rooting medium, the rooting of root-cuttings is a simple matter. Similar experiments in St. Lucia (see *Tropical Agriculturist*, Vol. LVIII—1922, page 99) support this result. Four medium sized roots cut into 6-inch sections to form 95 cuttings were inserted in nursery beds, the soil being covered to a depth of 3 inches with sea sand. In $4\frac{1}{2}$ months from date of insertion of cuttings, 58 had developed into strong vigorous plants of 6 to 7 inches high and at that date 35 of the remainder

had produced numerous buds, and only two were actually dead. It is fairly conclusive, therefore, that propagation by root-sections or root-cuttings is the remedy for the past and present difficulties in obtaining stocks of this valuable plant, and with similar methods of propagation now in hand at Peradeniya it is expected that very much larger supplies will become available in the future.

The small fruit grower or person with available ground could raise his own stocks if he has the necessary parent tree. The root cuttings are obtainable from the end of the growing root system, usually those just below the surface of the soil are best, selecting roots of from $\frac{1}{2}$ inch to $2\frac{1}{2}$ inches in thickness, cutting all such into lengths of 6 to 8 inches each with a very sharp knife and inserting into a prepared bed covered with a thick layer of coarse river sand. It is important that the operation should be conducted with the arrival of the Monsoon, and should dry weather intervene regular spraying must be done. The cuttings should be inserted to two-thirds of their length and 12 inches or so apart in the nursery bed in a sloping direction leaving one-third, and this the thickest end, above ground level and the whole bed shaded and protected during the hot part of the day. If the cuttings used exceed $1\frac{1}{2}$ inches in thickness the end exposed to the air after planting should be painted over with coal tar or a good preservative.

The rooted plants can be transferred from the nursery bed to permanent sites on attaining a height of 12 to 15 inches and should be planted at least 40 feet, but preferably 45 feet apart since the mature tree forms a very large and spreading head. Any considerable increase in the planting up of this tree in the Island must, in years to come, go a long way towards warding off any possible food shortage.

## JAK FRUIT

To increase the food production of the Island in conjunction with the provision of an excellent timber seems well worth striving for and this can be attained by the further encouragement of the cultivation of the Jak fruit (*Artocarpus integra*). The rural population need no enlightenment as to its food value, since in certain parts of Ceylon it is their most important food. At the time of the general food shortage some years ago, strenuous efforts were made in the cultivation of the Jak not only because of its food value but also because of its value as one of the standard timbers of Ceylon, and considerable stands were established by the Forest Department, by lessees on re-afforestation leases and by private individuals, but more remains to be done.

The two products of the tree, however, food and timber, unfortunately do not go well together, since in consequence of the shortage generally prevalent in the Island of good mature Jak timber, immature trees are too often sacrificed for this purpose and an important food producing asset is thereby considerably reduced.

In certain areas of village forest lands leased out for chena cultivation it has been stipulated that such areas should be re-afforested in Jak, and here and there good stands of young Jak trees are to be seen, but this is not enough. Every private individual in possession of even a small area or compound should endeavour to have his perennial source of food or fruit in the form of Jak or Breadfruit, Mango or similar kinds of trees.

It is no exaggeration to state that whole families live on the Jak fruit whilst the season lasts. The rural population is steadily increasing, but the supply of Jak trees for fruit purposes is equally steadily diminishing, for the recent extensions and activities of the Forest Department with this tree have been carried out naturally from a timber rather than a food product point of view.

The Jak is now naturalised in the country and is not difficult to grow in localities suited to it, that is, throughout the wet zone from sea level to 2,000 feet or even 3,000 feet, although it thrives best at the lower elevations. For the production of sound timber and for the best results as a fruit tree good cultivation *in the young stages* is necessary.

The numerous poor and malformed specimens seen in villages and around individual dwellings are doubtless accounted for by the fact that they originated from self-sown seedlings where seeds have been discarded from an earlier meal, and in spite of traffic and rough treatment in general have germinated and survived. The seedling is later hampered by being smothered by overhead growth, by damage from cattle, and by severe competition for nutriment with the roots of surrounding trees. Under these circumstances, good healthy and well-formed trees cannot be expected, and the elimination of these drawbacks by proper cultivation of seedlings, whether self-sown or planted, will amply repay the owner.

Where any well-established tree or trees exist under the conditions mentioned above, considerable improvement can be brought about by clearing off all cheddy around the roots, by lopping overhanging branches of unnecessary trees, or better still by the removal of such as are in close proximity, and by undertaking a heavy lopping of the Jak branches whereby new

growth is formed and light and air is afforded the tree. The Jak is a robust type of tree when once established and the crop from the new wood formed after the lopping will soon repay the labour involved in clearing around the tree and keeping it clear.

In addition to this, new plants should be put out to replace eventually the older trees, and these can be raised by selecting some seeds of the best and largest fruit available and sowing them either in a prepared bed or preferably in bamboo pots, or even in cigarette tins if holes are made at the bottom of the tins to afford drainage. The beds should be protected from cattle trespass and other damage and kept shaded for a time, or the pots or tins placed in positions where protection and shade is afforded. In three to four months from sowing, the seedlings will be large enough to plant out into permanent sites.

Good holes about 3 feet wide by 2 feet deep should be cut and refilled with a good proportion of well-rotted cattle manure, planting the seedlings after soil has settled down. A strong permanent fence should be erected around each plant and a little overhead shade during mid-day hours is beneficial for a time after planting, until the seedling can stand full exposure. The Jak is normally a straight-growing tree and naturally forms a good, straight free-growing stem, so that no pruning or shaping is usually required. The tree prefers a rich, deep and moist soil, but will also grow well in poor soil. Moisture however, seems essential and it can be said with safety that once established all it needs is ample moisture.

The fruit is not, like most other fruits, produced on the end of the branches, but is borne first on the main stem of the tree and then on the stems and bases of the branches, and the tree has, therefore, to form a certain maturity of wood before it fruits. This occurs in the low-country in about 5 to 6 years, and at 2,000 feet or so at about 6 to 7 years of age. From thence onward the crop increases until the tree reaches its full size. It is relatively a long-lived tree and produces heavy crops over a long period.

There are several varieties of Jak, those considered the best being the "Waraka" and the "Vela", the firm and soft fruited types respectively. Peradeniya possesses an outstanding tree of the "Waraka" which is much appreciated locally in respect to both its quality and its size. Heavy crops are borne annually also by this tree and propagation on a large scale has been undertaken at these nurseries,

# THE WHITE SPIDER ORCHID
## (ARACHNIS ALBA SCHLECHTER)

K. J. ALEX. SYLVA, F.R.H.S.,
*CURATOR, HENERATGODA BOTANIC GARDENS*

THIS pretty epiphyte is indigenous to the woods of the Malay Peninsula and is also known as *Renanthera alba* Ridl. and *Arachnanthe alba* Ridl. It belongs to the tribe of Vandeous Orchids and is very nearly allied to Vanda itself, differing however, in having the mid-lobe of the lip small and the lip being articulated—not continuous with the column, and spurred at its middle instead of at its base. As an ornamental pot plant it ranks with some of the best of its genus on account of its easy culture and free-blooming habit. The stem is terete, woody and usually about quarter of an inch in diameter, and sends out long greyish roots from the nodes. The stem usually attains a height of four to five feet in Ceylon and as many as fifteen to twenty feet in its native habitat, but starts flowering when about eighteen inches or so high. The leaves are coriaceous and oblong, bluntly serrated and alternately placed. The pale creamy white flowers are disposed in long slender panicles given off opposite the leaves at the nodes. The sepals are linear-oblong about three quarter of an inch long while the petals are curved at the apex, the lip being mottled with yellow blotches.

*Culture.*—Few orchids are more easy of cultivation than Renantheras. They will thrive on tree trunks, in pots or on the ground. *Renanthera alba*, though slender and delicate in appearance is a comparatively hardy species and will flower freely when adapted to its environment.

A well-grown plant may be severed from a point above the level of the pot and cut up into small sections with three or four nodes to each cutting. By this mode of propagation the stock soon puts forth fresh shoots with renewed vigour and good heads of flowers are produced. The cuttings should be planted in a mixture of chopped coconut husk, decayed wood, brick bats and charcoal and placed in the shade until at least they show signs of new root growth. At this time syringing should be freely done, as this will keep them sufficiently moist at the roots.

When the plants are about ten inches high they may be potted in perforated pots with the same compost used for cuttings and placed in a warm place to hasten flowering.

A well-grown specimen (see Plate VI,) will flower about three times a year producing blooms that will last over a month.

Plate VI. The White Spider Orchid

# TOBACCO CULTURE IN SOUTHERN RHODESIA*

THE operations of harvesting and curing are of supreme importance to the tobacco grower when viewed from the standpoint of financial return. The value of the tobacco is dependent upon quality, and unless proper care is exercised during the harvesting and curing stages, the financial returns may be seriously reduced through lack of quality in the cured leaf. Mistakes in either operation cannot be rectified when once made. The question of quality is of primary importance and it will become increasingly so with the growth of intensive competition with other tobacco-producing countries.

*Ripening Stage.*—The young tobacco plant, when growing vigorously, carries leaves of a deep green colour, which at this stage are soft and pliable. This intense green colour indicates a rich supply of nitrogenous constituents, which go to make up the vital or living parts of the leaf, and which are necessary for the building up of the food supply of the plant.

At about the time the leaves as a whole have reached their maximum power of elaborating the food supply, the flower head begins to develop. This food supply, consisting of starch and other similar substances, is carried from the leaf into the seed head to furnish the necessary food for the development of the seed. This accomplished, the leaves have completed their full task, and they now pass into the period of gradual decay. In practice, however, the tobacco plant is "topped" so that the seeds are not allowed to develop. Making a last effort to reproduce itself, the plant then sends out secondary shoots or suckers, but these, too, are removed by the grower. Under these circumstances the food supply elaborated by the leaves is not translocated to other parts of the plant, but accumulates in the leaves themselves. The result is that the leaf increases both in size and in body. The accumulation of plant food in the leaf induces ripeness, and later, unless the leaves are harvested, gradual decay. Should the plants make normal progress, the usual period required for the lower and middle leaves to ripen is about 90 days from the date of setting out in the field, the uppermost leaves ripening later.

Actual and personal experience is required before the grower is fully able to tell when the leaf is properly ripe, but the following explanation of the indications may prove of some assistance:

The first indication of ripeness is a pronounced change in colour, provided this change is not caused by conditions other than maturity in the plant. In seasons of severe drought or extreme wet the leaves will often turn yellow before the plant is fully ripe. Plants affected by disease will also change colour prematurely; root-gall is another common cause of this condition. The leaves of plants thus affected will not cure properly, and will lack the necessary quality.

* By D. D. Brown, Chief Tobacco Expert, in *The Rhodesia Agricultural Journal*. Vol. XXX, No. 3, March, 1933.

The dark green colour of healthy, light-textured leaf changes by gradual degrees to a greenish-yellow as the leaf reaches maturity, whilst in the case of heavy-textured leaf the change to a yellow colouration may be confined to only small areas of the leaf-surface and causing the ripe leaf to appear with yellow flecks or spots. A sign of ripeness in very heavy tobacco is to be found in the way the tips of the leaves curl in towards the stalk of the plant. The accumulation of starch granules within the leaf cells causes the leaf to become brittle and roughened; this change from being pliable and smooth to the touch is another indication of ripeness. Such leaf will crack when folded and pressed between finger and thumb.

Before being harvested, the tobacco leaf must be suitably ripe, and it is essential that the greatest care be exercised in picking leaf which is suitably ripe for the method of curing to be employed.

The correct degrees of ripeness desirable for each method of curing are:

Air curing—almost fully ripe leaf.
Sun curing—almost fully ripe leaf.
Flue curing—fully ripe leaf.
Fire curing—fully ripe leaf.

Many a promising crop of tobacco has been ruined in the harvesting and curing stages. A fairly common source of financial loss to tobacco growers is due to the practice of harvesting leaf which is unripe. Optimum results in the curing process depend upon certain factors, the correct stage of ripeness of leaf being one of the most important.

*Harvesting.*—Tobacco may be harvested by cutting down the whole plant or by the removal of individual leaves. The former method is generally employed in the case of sun-cured, air-cured and fire-cured tobacco. It is an economical method as regards labour requirements, but has the drawback that all the leaves on the plant are not in the same state of ripeness when harvested.

Flue-cured tobacco is harvested by the single leaf method as this system has proved to be particularly suitable and renders easier the filling of the barn with leaf uniform in ripeness and texture. In order to harvest all the leaves produced, it is necessary to take from three to six pickings off the plant.

When harvesting by the whole plant method it is advisable to use a proper tobacco knife to split the stalk down the centre to within about six inches of ground level; then, after holding the plant slightly down and away from the operator a slanting cut severs the stalk from the root. The plants are then allowed to wilt slightly, after which they are placed astride the curing sticks; one such stick will hold from six to ten plants, depending upon their size. The sticks, when filled with their complement of plants, are next placed on a trolley to be conveyed to the barn or curing racks as the case may be. The tobacco should be carefully handled, otherwise the leaves may become bruised and damaged.

In the single leaf system of harvesting, leaf of uniform ripeness is picked and then placed either in crates, baskets, "machilas" or sleighs specially constructed for the purpose. A very suitable receptacle made and used by many tobacco growers is a contrivance manufactured from ordinary bush poles

and hessian. The frame is made of poles (about 4 inches in diameter), the two top members extending about 12 inches beyond the end of the crate and serving as handles by which the receptacle is carried. For convenience in stowage the fixed handles might be replaced by detachable poles of the requisite dimensions passed under the top bars at either end and held in position by wire loops fixed at the four top corners. One set of such handles will serve for a number of these crates. A similar arrangement can also be applied to the iron crates now manufactured and sold by local firms.

Laths are placed across the bottom of the framework to prevent the hessian sagging when the crate is filled with leaf. The sides and ends are diagonally stayed with heavy gauge galvanised wire. Hessian is sewn inside the framework to cover the bottom, sides and ends of the crate. A loose flap is also sewn along the top of one side, and is used to cover the tobacco to protect the leaf from sun-burn.

These crates are carried about the field, and, when filled, are loaded, one on top of another, on a wagon. Individual crates may also be placed on a sleigh, and drawn to and from the field in this fashion. The containers holding the leaf are next carted to the stringing shed, which is situated in close proximity to the curing barns. Care should at all times be exercised, in the handling of the leaf, in order to prevent mechanical damage. Careless handling during the harvesting is responsible for much injury, due to the leaves becoming bruised and sunburned, and no matter how well the curing process may be carried out, it is impossible to repair this damage.

In the stringing shed the containers are carefully emptied, the tobacco being placed on tables or in small heaps close to the natives tying the leaves on to the sticks. These sticks are supported at each end by a post let into the floor, and are some three feet high above floor level. The leaves are tied up in bunches of two to five leaves (according to the size of leaf).

Cotton string is used for tying the tobacco, one end of the string being securely tied to an end of the curing stick before the operator commences to deal with the leaf. The string is held in one hand, and with the other a bunch of leaves is placed in position close to the stick. The string is then wound round the leaves (not more than one inch from their "butts") one and one half turns before they are passed completely over and across the stick to complete the operation. In tying the leaves the string should always be wound round in the direction away from the operator. The next bunch of leaves is placed on the opposite side of the stick in order that the alternate bunches will balance the stick when filled.

When a sufficient number of bunches has been placed on the stick (usually 32 bunches) the free end of the string is wound round and tied to the end of the stick, which is then ready for hanging in the curing barn.

In cured tobacco the colour, texture and quality of the leaf are the important features. When harvested before the proper time the leaf will retain a green colour and if picked when over-ripe the colour will be uneven and blotchy, besides being harsh and lacking in quality. Leaf which

cures out a deep green colour is of little or no commercial value, so if an error is to be made, it is better to err on the side of picking over-ripe leaf rather than green leaf, for over-ripe leaf has some commercial value when offered for sale.

For flue-cured tobacco it is essential to fill each curing barn with leaf in the same state of ripeness, for when tobacco in varying stages of ripeness is placed in the barn, all of the leaf will not cure at the same rate, and will, therefore, not be uniform in colour when cured. The leaf filled into each barn should also be of uniform texture for the same reason. Close personal attention to these details is required from the grower if a frequent cause of serious loss is to be avoided.

*Curing.*—It is estimated that approximately 80 per cent. of the total weight of tobacco as harvested is comprised of water.

In the curing process this moisture is gradually expelled from the tissue of the leaf, and certain chemical and physiological changes take place which bring about the formation of those desirable qualities in properly cured tobacco.

During curing the leaf is subjected to gradual starvation, regulated by certain conditions. If by means of excessive heat or protoplasmic poisons the cells are prematurely killed, the leaf will not be properly cured, and will consequently lack in essential qualities. The principal factors by which the curing is controlled are heat and moisture. There are four methods of curing tobacco in general use, viz., air-curing, sun-curing, fire-curing and flue-curing, and the conditions for one method may not be applicable to another.

The purpose for which the tobacco is to be used, as well as the climatic and soil conditions under which it has been grown, largely determine the method of curing. The abbreviated list given below indicates the several methods of curing, and the types of tobacco cured by each method:

| | |
|---|---|
| Air-cured— | |
| Cigar tobacco<br>Burley<br>Stemming<br>Transvaal tobacco<br>Australian tobacco | Cigars, pipe mixtures, chewing, snuff and cigarettes. |
| Sun-cured— | |
| Turkish<br>Maryland<br>Virginia<br>Rhodesian<br>Indian | Cigarettes, smoking and chewing. |
| Fire-cured— | |
| Virginia dark<br>Kentucky dark<br>Tennessee dark<br>Nyasaland dark<br>Rhodesian dark<br>Canadian dark<br>Uganda dark | Chewing, smoking, snuff and cheap cigars. |

Flue-cured—

| | |
|---|---|
| Virginia bright<br>Carolina bright<br>Nyasaland bright<br>Rhodesian bright<br>Canadian bright<br>Indian bright<br>Australian bright<br>Transvaal bright | Cigarettes, pipe mixtures, chewing and snuff. |

*Air Curing.*—This method of curing is the simplest, and is very extensively employed; a great part of the world's tobacco supply is thus cured. Air curing is a natural process for the tobacco is harvested and placed in the barns to be cured by natural atmospheric conditions. The results obtained are dependent upon climatic conditions, and if the conditions are ideal, and proper care has been taken in harvesting, the tobacco will cure out well.

In order to overcome the effects of unfavourable weather conditions on the curing, growers have of recent years introduced artificial means (heat and moisture), which somewhat modify the process.

When an excessively dry and hot spell sets in immediately after the tobacco is placed in the barn, the curing is rendered difficult and unsatisfactory, as the leaf may be killed prematurely, thus causing poor colour and a lack of desirable qualities. When wet weather prevails, heavy loss may be caused through "pole-sweat," and the colour of the leaf may be adversely affected. The ideal climatic conditions for air-cured tobacco are obtained when the weather is calm and clear, with a shade temperature of from 80 degrees to 90 degrees F., and a moderately dry atmosphere. When the above conditions obtain, the moisture given off from the leaf is readily absorbed by the atmosphere, thereby lessening the chance of oxidation taking place. Under ideal conditions the bulk of the leaf should cure out a moderately bright colour.

The occurrence of wet weather during the final stages of curing and before the tobacco is removed from the curing shed, will cause the leaf to turn red. Normally the time required for air curing is from between six weeks to twelve weeks, depending upon the nature of the tobacco and the climatic conditions prevailing during the curing process. When the single leaf method of harvesting is employed the curing will take less time than would be required in the case of curing the whole plant.

The purpose for which the tobacco is to be used in a great measure determines what the desirable colour of the leaf should be. For cigarette purposes the leaf should be lemon yellow to light orange in colour, whilst leaf for pipe mixtures, plugs and twist will range from light red to dark brown. In the case of cigar tobacco the most desirable colours are brown and olive shades.

Normally, all leaf turns a yellow colour before it begins to dry out. If it dries before yellowing, it will remain a green colour, and consequently be of little or no commercial value. When the drying is delayed too long after the yellow colouration appears, oxidation takes place, and the leaf will turn a reddish or brownish shade.

When filling the curing shed the sticks of tobacco are hung up on tiers, starting from the topmost tier and working down to the lowest. Much damage may be caused through placing sticks, holding the entire tobacco plant, in the wrong order. Any one tier should not be filled before another is commenced. The correct procedure is first to place one stick on the highest tier. The following stick is placed on the next tier down, with the butts of the tobacco plants just touching the tips of the plants suspended from the stick above. The next stick should then be hung on the third tier down, and placed in similar relation to the stick above, as indicated for the first and second sticks placed in the barn. This order of filling is continued until the bottom stick has been suitably placed on the last tier, when the same order is observed by commencing again at the top and working downwards as before. This is continued until one section or "room" is filled. Each section is completed in proper sequence until the barn is fully packed. The filling of a barn should be commenced at a point furthest away from the door, leaving that section by the door until last.

At first the tobacco sticks are placed along each tier at intervals, which allow the plants to touch, but they must not be in too close contact. The usual spacing allowed is about six to eight inches, depending upon the length and girth of the plants. Later on, when the tobacco is well yellowed in the barn, the spacing between each stick may be increased in order to hasten the drying process. During excessively dry weather the sticks of tobacco should be kept closer in order to prevent the leaf drying out too rapidly, and to enable it to turn a suitable yellow colour.

The atmospheric conditions in the barn should be so controlled that the relative humidity is fairly high during the wilting process, the wet bulb of the hygrometer registering between 2½ degrees to 3 degrees below the dry bulb. If the difference in reading between the wet and the dry bulbs be greater than 3 degrees more moisture should be introduced into the barn. On the other hand, should the difference be less than 2½ degrees, the humidity must be reduced by ventilation or by heating. The temperature of the barn should be maintained at from 70 degrees F. to 75 degrees F. during the wilting process. When the tobacco has changed to a pale greenish-yellow tinge the temperature should be increased to 80 degrees F. and then to 90 degrees F. The relative humidity should be decreased in order to allow the leaf to commence drying. Care must be exercised at this critical stage in the curing otherwise the tobacco may become spoiled either through drying too quickly and remaining green or through excessive moisture and delayed drying causing sponging and, in extreme cases, pole-burn.

After the leaf has yellowed the rate of drying should be gradually increased by use of ventilators. In barns fitted with flues the curing may be hastened by lighting the fires. Another method of curing is possible by removing partially cured tobacco from the air-curing barn and completing the curing process by the sun-cured method.

As an alternative a combination of the air-cured and sun-cured methods may be adopted. The tobacco is first placed in the air-curing barn and is wilted and yellowed in the usual manner, after which it is removed from the barn and the curing process is completed by the sun-cured method. The partially cured tobacco is conveyed to the curing racks, where it is exposed to the direct rays of the sun until the leaf is thoroughly dried out.

Speaking generally, climatic conditions during the early part of the season are not conducive to good results, and if air curing were to be properly developed in Southern Rhodesia it would be necessary to utilise suitable air-curing barns. In other countries where this method of curing is practised the barns are both elaborate and costly. The erection of grass sheds in which the tobacco is more or less exposed to the elements cannot be recommended and disappointing results may be expected.

*Sun Curing.*—Sun curing is similar to air curing, in that no artificial heat is employed. In other features, however, it differs. In this method the rate of curing is hastened by exposing the leaf to the direct rays of the sun, whilst in air curing the curing is primarily regulated by atmospheric conditions.

In addition to a packing shed, bulking shed and conditioning pit (all of which are necessary on any farm where tobacco is produced), a wilting room and curing racks are necessary equipment.

The wilting room is used for yellowing the leaf before the tobacco is placed out on the drying racks. A suitable room is fairly dark and cool, and besides being used for wilting, may also serve for conditioning the cured leaf.

The packing shed should be furnished with roof lights, as this means of lighting is more satisfactory than when side windows only are employed. Grading of the leaf can be done in this building, besides the baling of the leaf after grading.

The bulking shed requires no elaborate lighting, but should only have sufficient light to enable the bulking operations to be properly carried out.

The drying racks are made from native timber or native timber posts and plain heavy gauge galvanised wire. In the former case, posts are set into the ground, and the light sticks, forming the rails, are attached to them; while in the latter case, the wire forms the rails in place of the light sticks. The conditioning pit is used for softening the cured leaf.

The dry leaf is placed in the pit, and after hanging there for a time, the web of the leaf will have absorbed sufficient moisture to make it pliable and fit for handling without breakage. A suitable pit is made by digging a rectangular hole in the ground and roofing it over with grass or reeds and earth. Where grass is employed, a pitched roof should be built. The site selected for the conditioning pit should be one where water will not seep through to such an extent that the pit will be flooded.

In sun curing, the whole plant is usually harvested, but the single leaf method may also be employed, especially where the leaf is to receive the final stages of curing in a flue-curing barn. The usual practice followed in sun curing is to harvest the tobacco just before it is fully ripe. The plants, after being placed on sticks, are put into the wilting room until the leaf turns a greenish yellow. When the leaf is properly yellowed it is removed from the wilting room and placed on the drying racks, where it is exposed to the direct rays of the sun until both the web and midrib are thoroughly dried out. The time usually required for sun curing is from four to six weeks. Some means of covering the tobacco on the curing racks is required for use during the night, and in the event of rain, during the day. The

tobacco may be covered with bucksails, hessian or grass mats. After the tobacco has been on the racks from four to six weeks, it should be ready for removal to the conditioning pit. The removal of the cured tobacco from the racks should be carried out, if possible, when there is a certain amount of moisture in the atmosphere, either during misty weather or early in the morning before the heat of the sun dissipates the moisture absorbed by the leaf overnight.

A great deal of damage may be caused through handling the cured leaf when it is in a brittle condition. It is usual, therefore, to wait until the leaf absorbs sufficient moisture from the atmosphere, when climatic conditions are favourable, before removing the tobacco from the curing racks.

Where it is absolutely essential to have the tobacco removed from the racks within a certain time, growers may sometimes resort to the expedient of taking down the sticks from the racks about sundown, and placing them flat down on the grass, where, by leaving the tobacco fully exposed to the dew overnight, the leaf will become soft enough for handling by sunrise the next morning. Should the dews be heavy, the tobacco will lose colour through becoming wet, so this practice is not to be recommended, except in cases where it is imperative to have the tobacco removed from the curing racks within a certain time.

In order to assist in the production of good quality sun-cured leaf, the crop should not be planted too early in the season, but it should be transplanted so that it will be ready for harvesting about the time when the rains normally cease.

The sun-curing method can be recommended where soil and climatic conditions are suitable for the production only of a heavy type of tobacco.

Plants producing leaf too heavy for flue curing satisfactorily may be found in many fields of flue-curing tobacco, especially round ant-heaps. The leaf of such plants should first be wilted, and may then be sun-cured until the leaf is dry. It should then be placed in the flue barn, and the midrib dried out.

Sun-cured tobacco differs somewhat from air-cured leaf, and possesses certain desirable qualities. It is usually lighter and more uniform in colour, and is sweeter and more aromatic. This type of leaf is used for chewing and for pipe mixtures.

*Fire Curing.*—This method of curing tobacco calls for the use of fire during the curing process. Heat is applied by means of open fires placed in trenches directly beneath the tobacco. The smoke from the burning wood imparts a creosotic flavour and peculiar aroma, besides improving the keeping qualities of the cured leaf.

The production of this type of tobacco can only be recommended where soil and climatic conditions are suitable for the production of a heavy type of leaf. The quality of the tobacco should be of a high standard.

For fire curing, suitable barns are required. Plans and specifications of such barns are contained in Bulletin No. 617.

Tobacco to be cured by this method should be heavy bodied, smooth textured, with large oily leaf rich in nitrogenous constituents. The soil for the production of tobacco suitable for fire curing should contain high

percentages of humus, clay and silt, and be naturally fertile and well drained. Liberal applications of kraal manure or fertilisers should be used in order to further increase the growth of the plant. When fertilisers are used, the nitrogen contained therein should be mostly derived from an organic source, such as fish meal. The plants are topped low in order that only large leaf is produced.

The plant is not harvested until it has become fully ripe, the whole plant method being practised as described under "harvesting". After the tobacco has been placed on the sticks and been allowed to wilt slightly, it is carted to the barn and placed on the tiers. In filling the barn the proper procedure is to place the first stick of tobacco on the top tier, then the next stick on the second tier, and so on, until the bottom tier is reached. This procedure is repeated until that room or section of the barn is completely filled with tobacco sticks. The sticks are placed at six to nine inch intervals along the tier, care being taken not to crush the tobacco leaves between the sticks, or to damage the tobacco by placing the next stick directly beneath those plants hanging on the tier above. After the tobacco has been hanging in the barn for a period of from four to six days, the leaf should be yellow, and when the tobacco has reached this stage, small fires are lighted in the trenches dug in the floor of the curing barn, and the temperature of the barn is gradually increased to about 100 deg. F. This temperature is maintained until the tip and edges of the leaf begin to curl and turn brown, when the fires are put out and the barn allowed to cool down; this will allow the sap to become uniformly distributed through the leaf, and the brownish parts of the leaf become pliable. The fires are then restarted, and the temperature raised to a few degrees higher than during the preceding stage.

When the brown colour begins to spread from the edges of the leaf towards the midrib, and the brown coloured part of the leaf becomes brittle, the fires are again removed to allow the barn to cool down and the sap to spread. This process is repeated, and as the curing progresses the temperatures are increased each time after the fires are restarted.

It is seldom advisable to raise the temperature higher than 125 deg. F. The cured leaf should be of good size and body and a uniform dark brown colour.

The desirable qualities of the cured leaf may be seriously affected through being subjected to excessive quantities of smoke, which may leave heavy deposits on the leaf and blacken the tobacco to a great degree. Certain wood gives off an unpleasant odour when burned, and should this be taken on by the tobacco, it is undesirable.

The fuel used for burning in fire-curing barns should be selected from hard woods which do not create any unpleasant smell whilst burning.

After the curing is completed, the tobacco is brought into condition in a similar manner to that already described under air and sun curing. The leaves are then stripped from the stalk, graded according to size and colour, tied up into hands, and bulked preparatory to baling.

The time taken for fire curing is between two and three weeks, according to the size of the tobacco and climatic conditions. Should the curing be carried on at too fast a rate, the quality of the leaf will be of low grade and little commercial value.

*Flue Curing.*—This is the method generally used by the growers of tobacco in Southern Rhodesia, and for which the majority of the tobacco produced is most suited. The rate of curing in this method depends upon the use of artificial heat, and the process calls for specially designed barns. Specifications and plans of suitable flue-curing barns have previously been published in this Journal, and reprinted as Bulletins Nos. 605 and 661.

Heat is generated in the furnaces by means of wood fires, and flues radiate this heat into the barn. Coal may also be used in properly constructed furnaces.

Flue curing is the most modern method of curing tobacco, and requires constant and careful attention to all details connected with it. The skill and care exercised during the curing have a direct influence on the value of the tobacco produced. The colour most sought after is a clear lemon yellow, and this leaf brings the highest price. Varied colours are found in every barn cured, and green is the colour least desired. Care in picking will considerably reduce the quantity of green-coloured leaf. Leaf which gives the best results is fine textured and silky. *There are many formulas advanced for this method of curing, and any one may be correct under certain conditions, but they cannot all be correct at one and the same time.* The type of leaf and the climatic conditions obtaining during the process will largely regulate the rate of curing. For instance, heavy leaf will be longer in curing than light leaf, and leaf which is yellow when picked will cure faster than green-coloured leaf. Higher temperatures are required in wet weather than in dry weather, and lower temperatures are required in cool weather than in warm weather.

The state of the atmosphere outside the barn has also to be considered in regulating the ventilation of the barn during the time the tobacco is being cured. A dry outside atmosphere calls for reduced ventilation through bottom ventilators, and the top ventilation should also be reduced to a minimum, so that the leaf will not dry out too rapidly and possess an undesirable green colour.

During wet weather the bottom ventilation is reduced and top ventilation is increased, in order that the moisture-laden air may be driven out of the barn.

During excessively wet spells, and when the leaf is heavy bodied and contains a good deal of moisture, it may sometimes be advisable to open slightly the top ventilators, when the temperature in the barn reaches 105 deg.-110 deg. F., and by this means reduce the amount of "sponging" which often takes place when the barn is kept closed, until a temperature of 115 deg. (the temperature to be reached before ventilation is recommended under normal conditions) is registered within the barn.

In the event of conditions requiring the above system of ventilation, the top ventilators are at first opened to a very small degree, and the opening gradually increased in order to drive off the excess moisture from inside the barn. The bottom ventilators should be kept closed at this stage of the curing, or only a very limited amount of ventilation allowed, as excessive ventilation through the bottom vents would defeat the object in view by introducing a fresh stream of moisture-laden air into the barn.

In flue curing there are three distinct stages through which the leaf must pass, namely, yellowing the leaf, fixing the colour, and drying the leaf and midrib. In Rhodesia the single-leaf method of harvesting is used, but in other countries, where the whole plant is put into the flue-curing barn, a fourth stage is required, namely, the killing of the stalk.

*Yellowing Stage.*—The barn is filled with leaf of the same texture and ripeness. The filling of the barn should be accomplished in one day, so as to assist the tobacco to cure evenly. A thermometer and hygrometer are suspended from the bottom tier in the middle of the barn; a suitable thermometer should be graduated in single degrees up to 170 deg. F. The hygrometer has both a wet and dry bulb; the latter should have the water receptacle filled with water when placed in the barn. As soon as the barn has been filled the door and ventilators are closed to prevent the escape of moisture. Small fires are then made in each furnace, and these are increased in size until the temperature of the barn is raised to 90 deg. F.

In the early stages of curing, a low temperature is essential until the leaf yellows; a high temperature at this stage would ruin the tobacco. The temperature is therefore kept at 90 deg. F. until the leaf starts to yellow at the tips and round the edges. This having occurred, the temperature is gradually raised to 95 deg. F., and this temperature maintained until the yellow colour begins to spread in towards the midrib of the leaf. The temperature is then increased gradually to 100 deg. F., and maintained at this temperature until the yellow colour is more pronounced.

During this time, the atmosphere of the barn should be saturated to prevent the leaf from drying out. Enough moisture must be kept in the barn to give a reading of 3 deg. or 4 deg. difference between the wet and dry bulbs of the hygrometer; the wet bulb should only register 3 deg. or 4 deg. below the temperature recorded on the dry bulb. When the wet bulb registers more than 4 deg. below the dry bulb, the indication is that the atmosphere within the barn is becoming too dry, and should this be the case, it will be necessary to introduce more moisture into the barn by pouring water on the floor and lower walls. In place of water, low-pressure steam may be introduced until the required degree of humidity has been attained.

When the leaf begins to show more yellow in colour, the temperature is increased to 110 deg. F., and this heat maintained until the leaf is yellow, with only a slight greenish tinge. The temperature is then gradually raised to 115 deg. F., and held there until the proper yellow colour is obtained. Between the temperatures of 100 deg. F. to 115 deg. F., the amount of moisture in the atmosphere of the barn is gradually reduced until the wet bulb registers from 6 deg. to 7 deg. below the dry bulb. Maintaining the correct amount of moisture in the barn during this stage is very important.

*Fixing the Colour.*—This is the most critical stage in the curing, and it is here that many a barn of good tobacco becomes spoiled. The greatest care in the manipulation of the barn is required at this period of curing. The leaf will turn to reddish brown colour if the atmosphere of the barn is too humid, or if the ventilation is inadequate and the temperature is not increased fast enough. This discolouration of the leaf is known as "sponging", and is

caused through moisture collecting on the surface of the leaf. Another discolouration is caused through the cells of the leaf being prematurely killed, preventing the necessary chemical changes taking place. This happens when the ventilation is excessive and the temperature is increased too rapidly; the leaf in this case has a dark greenish red or blackish colouration. Sponged tobacco is of more value than green or blotched leaf, but the grower should try to eliminate all three classes of leaf.

The main object in fixing the colour is to try and prevent any further change in the colouration of the leaf after the yellowing stage is passed. The barn should be so managed that the moisture is carried off through the ventilators as fast as it is given off by the leaf. The temperature is regulated in such a fashion that the colour will be normally fixed in 15 to 18 hours. The top and bottom ventilators are slightly opened when the leaf is of the proper yellow colour, and the temperature registers 115 deg. F. When the ventilators are opened, the fire should be slightly increased to prevent the temperature of the barn falling below 115 deg. The ventilation is next slightly increased, and the temperature is still maintained at 115 deg. until the tips of the leaves begin to curl upwards. The next step is to increase the temperature to 120 deg. F., and hold it there until the leaf begins to curl in towards the midrib. The leaf is now drying, and the temperature is further increased to 125 deg. F., this temperature being maintained until the web of the leaf is about dry.

*Drying the Leaf.*—To complete the curing it is necessary completely to dry the leaf, and this is accomplished by raising the temperature from 125 deg. F. to 130 deg. F. in two hours' time, after the web of the leaf appears to be dry. The temperature of 130 deg. F. should be maintained for about four hours, then raised to 135 deg. F. in one hour, and held there for about four hours, when the web of the leaf should be thoroughly dried out. Ventilation is next reduced, and temperature increased hourly by about 5 deg., until a temperature of 160 deg. F. is maintained until the midribs of the leaves are dry and brittle. A temperature in excess of 160 deg. F. is not recommended, nor should it be necessary except where the whole plant method of harvesting is employed, in which case the maximum is 180 deg. F.

By using temperatures in excess of 160 deg. F., growers cause a decline in the quality of their tobacco. High temperatures render the leaf very brittle, and it lacks the soft silky feel necessary in high grade tobacco. The colour of the leaf is also impaired and rendered dull, instead of having a lively appearance. Normally, the time required for curing tobacco in flue-curing barns is between four and six days.

*It must be clearly understood that the above temperatures are given only as a guide, and while being correct under certain conditions, they are not expected to be suited to the curing of every barn of tobacco during each and every season.*

The grower will find the above guide useful in deciding how the curing is proceeding, and by modifying the temperatures, moisture and ventilation, will be enabled to arrange the rate of curing to suit the type of leaf in the barn and the climatic conditions prevailing during the period of the process.

*Handling the Cured Leaf.*—The characteristics of the cured tobacco are either improved or spoiled in the subsequent handling of the leaf. It is not proposed here to discuss the handling of tobacco after it has been cured, as this phase of tobacco culture has already been fully dealt with in Bulletin No. 641, issued by authority of the Minister of Agriculture and Lands.

In conclusion, it may be stated that to become thoroughly proficient a tobacco grower needs to gain experience through the actual handling of the crop, for there are certain details in connection with the growing, harvesting, curing and handling of tobacco which cannot be fully grasped through perusal of reading matter alone.

## SUMMARY

(1) The harvesting of tobacco, whatever be the method adopted for curing, is very important, and has a large influence on the value of the cured product.

(2) Get to know when a leaf is ripe, and harvest leaf which is suitably ripe for the process by which it is to be cured.

(3) Uniformity in harvesting makes for uniformity in curing.

(4) Green tobacco is of low value; take every precaution to produce the absolute minimum of undesirable leaf.

(5) Harvesting of tobacco is facilitated by having adequate barn accommodation.

(6) The tobacco should be carefully handled during the harvesting otherwise damage may result for which you have to pay.

(7) The curing of tobacco is a scientific process, and requires to be studied as such.

(8) Buildings suitable for the purpose are an aid to satisfactory curing.

(9) Do not overcrowd the barn; it costs money when the leaf is damaged through being too tightly packed for curing.

(10) Have your buildings and plant for curing put in working order before the crop is due for harvesting.

(11) Provide for adequate supervision throughout the harvesting and curing of the crop.

(12) Endeavour not to grow more tobacco than can properly be accommodated in your buildings; excessive quantities of tobacco in relation to housing accommodation usually lead to the production of a lower grade leaf.

(13) Every effort should be made to produce quality rather than quantity.

(14) Make provision for future fuel requirements by planting trees to replace the indigenous timber already cleared off the land.

# THE PRESENT POSITION AND FUTURE PROSPECTS IN RELATION TO THE BIOLOGICAL CONTROL OF PRICKLY-PEAR

[This report by Alan P. Dodd, Officer-in-Charge of the Commonwealth Prickly-Pear Board's investigations, is extracted from the Journal of the Council for Scientific and Industrial Research, Commonwealth of Australia, Vol. VI, No. 1, February, 1933.—Ed., *T. A.*]


## SUMMARY

THE past three years have brought a very great change in the prickly-pear situation. Wide-spread destruction of the pest has followed the general establishment of *Cactoblastis,* to such an extent that the greater part of the original pear has collapsed in Queensland and the northern areas of New South Wales. In Queensland a vigorous policy of the development of pear lands for closer settlement is being pursued—a wonderful tribute to the efficiency of insect destruction.

But there is still particular need for scientific research and investigation. Re-growth which invariably springs up after the initial collapse of prickly-pear, is a feature of the situation in many districts. Although *Cactoblastis* destroys this secondary wave of the pest steadily, the Board is making a special endeavour to establish other insects for its more rapid control. Natural parasites kill a percentage of the *Cactoblastis* population; mortality from these agencies is not a serious factor and does not appear to be increasing; nevertheless, the question demands continued study. In the Hunter River districts of New South Wales, insect destruction has been much slower than elsewhere, but is now giving promise of eventual success.

The tiger-pear, *Opuntia aurantiaca,* which spreads very rapidly, is being made the subject of a special investigation for the introduction of its particular insect enemies. The tree-pear (*Opuntia tomentosa*) position in Central Queensland is being watched carefully.

In conclusion, it should be emphasized that the biological control of prickly-pear has been, up to the present, an outstanding success—a success that could hardly have been visualized five years ago.


## 1. PROGRESS TO MAY 1929

The last publication by the Board dealt with the progress of the biological control investigations to May, 1929. At that time, cochineal [1] was generally established throughout the pear areas: it had considerably reduced the height and density of the pear infestation in the heavily-timbered brigalow and belar scrubs, and had brought about very effective destruction of *Opuntia stricta* in Central Queensland. The prickly-pear red spider, *Tetranychus opuntiae* had co-operated with cochineal in the

(1) This cochineal insect (*Dactylopius tomentosus*) introduced into Ceylon from Australia in 1925 has satisfactorily controlled prickly-pear. (See *T.A.* for November 1926 and August 1930.—Ed., *T.A.*)

thinning out of the dense pear in the scrub areas. The plant bug, *Chelinidea tabulata*, was established in enormous numbers at many points, where it was assisting to control the fruit and new growth of the pear. The large-scale distribution of *Cactoblastis cactorum* [2] had been commenced; around some of the centres where the earliest experimental liberations in 1926-27 of this insect had been placed, the destruction of the pest over areas of from a few to 1,000 acres indicated, in some degree, the remarkable progress that might be expected in the near future. But the greatest success had been achieved in the virtual checking of the spread of the pest, a huge increase estimated at nearly 1,000,000 acres annually, as a result of a combination of insect activities and of energetic poisoning methods adopted or enforced by the State prickly-pear organizations.

## 2. PROGRESS SINCE MAY 1929

The campaign of *Cactoblastis* distribution was carried out on a most expensive scale by co-operation between the Board and State authorities, and was practically completed by the end of 1930, when 3,000,000,000 eggs of this insect had been released throughout the length and breadth of the entire pear area of Queensland and New South Wales, either by direct Government action or through supplies given free of cost to landowners. So quickly did *Cactoblastis* become established that, by the end of 1931, it could be said that it existed on practically every acre of the tremendous pear infestation of both States; and so rapidly did it increase that wide-spread collapse of the primary pear followed its activities in every district except the more southern pear area of New South Wales.

Thus the past three years have witnessed a very sudden change in the prickly-pear situation. The success of *Cactoblastis* has been most spectacular. Over enormous areas the original dense pear, that had flourished unchecked for years, has been destroyed. This statement is not intended to convey the impression that the pest has been completely annihilated, for a secondary growth is present in greater or less degree, the re-growth question will be discussed more fully in a special section of this review. As an example of the remarkable progress achieved by *Cactoblastis,* one instance may be given. In August 1930, the continuous and almost unbroken pear belt along the Moonie River, Southern Queensland, showed for 150 miles no destruction, and so light an infestation of *Cactoblastis* that further distribution was considered. However, the increase of this insect was so rapid that in August 1932, two years later, 90 per cent. of the primary pear had disappeared. In Queensland the chief remaining large belt of the two pest pears, *Opuntia inermis* and *Opuntia stricta,* is between Goodiwindi and the Moonie River. Probably 80 per cent. of Queensland's dense primary pear has been destroyed. Very fine results have been achieved in the north-west and the Pilliga State Forest areas of New South Wales; it is estimated that the primary pear has been reduced in all pear districts of that State, excepting the Hunter Valley and Camden districts, by from 50 to 60 per cent.

(2) A previous report indicates that the larvae of this moth, an introduction from the Argentine in 1925, live within the prickly-pear segments eating out the interior. The larvae may also penetrate into the underground bulbs and even the roots of the plants, and with the aid of associated rots the clumps may be entirely killed. The present report indicates that re-growth may occur, but that *Cactoblastis*, with the help of other enemies, may be expected to control this re-growth.—Ed., *T.A.*

But as the effectiveness of *Cactoblastis* has increased, that of the other pear insects has diminished. The dense concentrations of *Chelinidea tabulata* have decreased in the past two years to rather scattered numbers. Red spider, as an effective controlling agency, no longer counts. The sphere of usefulness of cochineal has been restricted to the sporadic destruction of new growth. The favourable results at the present juncture can be attributed mainly to the work of one insect, namely *Cactoblastis*.

## 3. RECLAIMING OF THE LAND

The Queensland Government immediately took advantage of the first wide-spread destruction of prickly-pear to promulgate a comprehensive scheme for the development for pastoral, grazing, and agricultural purposes, of land retrieved from the pest by insect agency. The programme is being pushed forward expeditiously. Already 1,514,881 acres of pear land have been re-selected for mixed farming operations, and 1,701,308 acres for grazing, all with development conditions. Ring-barking and felling of the useless timber, the clearing of roads and fence lines, and the erection of fences are proceeding apace. The homes of new settlers have made their appearance. Artificial grasses are being sown as the clearing of the timber progresses. Crops have already been grown successfully.

This marked evidence of progress is an outstanding tribute to the success of the biological control campaign. Within the next few years, great areas of former useless pear land will be brought into productiveness. The many new settlers will mean the growth of townships within the former prickly-pear area. Indeed, at Chinchilla, a new butter factory, shops. etc., already point to greater expansion in the near future.

The development of pear lands, except in the case of a few small areas, has been possible within the past two years only. Hence the work of bringing the reclaimed land into productiveness is as yet in its initial stages.

## 4. THE OTHER SIDE OF THE PICTURE

The spectacular destruction of *Cactoblastis* has tended to give the impression that the prickly-pear problem has been completely solved, and that no further research work is necessary. When the extent of the collapse of the primary pear is realized, and when mile after mile of dead and rotting pear is viewed, the tendency to magnify the admittedly wonderful results and to overlook the incompleteness of the destruction is natural. It is therefore necessary to point out in what manner the destruction is incomplete, and to indicate the many aspects of the problem that require continued attention.

(i) *Re-growth.*—Care has been exercised in the foregoing sections of this article to distinguish the destruction by *Cactoblastis* as the collapse of the primary or original prickly pear. But this destruction, spectacular as it has proved, is far from meaning the complete annihilation of the pest. Immediately after the initial collapse of the pear, one sees nothing but dead pear for a few months. The butts and roots, however, have not been completely destroyed, and when the growing season of the plant, September-December, arrives, re-growth appears. A secondary growth is not peculiar to insect destruction, for it invariably springs up after poisoning operations among dense pear.

In the early days of *Cactoblastis* progress, re-growth was not a pronounced feature. The separate areas of destruction were not extensive, and the insect population in the surrounding standing pear soon overflowed on to the new growth, and brought about its control rapidly. But when the activity of *Cactoblastis* encompassed the collapse of the whole or major portion of the primary pear in a district, the population of the insect suddenly dropped through starvation to very low numbers, and the small residue was quite inadequate to destroy the recurring growth immediately.

The first big wave of re-growth arose in the early summer of 1930. In many areas, it was subjugated during the summer by *Cactoblastis,* which occurred in very large numbers in other portions of the same districts. However, in the Chinchilla district the vigorous re-growth flourished unchecked throughout 1931; the *Cactoblastis* infestation, at first very light, increased in each succeeding generation, and the new growth was brought under control in the 1932 winter, or nearly two years after its appearance.

Another example of the control of re-growth may be given. In December, 1931, a very dense and vigorous re-growth over several thousand acres on the eastern side of the Mungle Scrub, New South Wales, had reached the fruiting stage. The *Cactoblastis* population, which must have light indeed eighteen months earlier, was now most satisfactory. Six weeks later, at the end of January 1932, the whole of this re-growth had collapsed.

Following the great advance of destruction of primary pear, the recurring growth of the 1931 summer involved very considerable areas. Much of this secondary wave of the pest still flourishes, fifteen months later, and in places has recently flowered and fruited. However, *Cactoblastis* is present wherever re-growth occurs. This succulent type of pear is the most favourable medium for the rapid increase of the insect, and there is no reason to expect that the control of existing areas of the re-growth will not be brought about within a short space of time. In Central Queensland, for some reason, possibly because of dry winter and early summer months, re-growth has not attained dense proportions, and has not escaped, even if temporarily, the attention of *Cactoblastis*.

In June 1931, the Board decided that, although the prospects of control by *Cactoblastis* were exceedingly hopeful, it would be unwise to leave the eventual control of re-growth to *Cactoblastis* alone. Hence a programme for the introduction of new strains of cochineal was commenced. Supplies of these insects have been secured from several places in America, and are being reared, with a view to their distribution in the near future. Furthermore, an endeavour is being made to import from North America a particular insect, *Mimorista,* the caterpillars of which feed on young growth solely. With these insects co-operating with *Cactoblastis,* it is hoped that more rapid control of re-growth may be brought about.

(ii) *Natural Enemies of Cactoblastis.*—The future of *Cactoblastis* depends upon the extent of the controlling influences exercised by disease and parasitic agencies. Disease organisms are always present among the

larvae, and have at times assumed serious epidemic proportions. However, as outbreaks are sporadic, and appear to be restricted to localities where the larvae are heavily concentrated, diseases are unlikely to bring about control of this insect.

Several native parasites have already turned their attention to *Cactoblastis*, and two have assumed some importance. The investigation of the habits and the controlling effects of these parasites is an important phase of the Board's work. Records of the degree of parasitic attack are gathered from many different localities, in order that the general position in the various districts may be gauged. At present, the control by parasites averages 15 per cent. in Central Queensland and north-west New South Wales, 5 to 10 per cent. in southern and south-west Queensland, and 20 per cent. in the Hunter River districts, New South Wales. Thus, parasites are not exercising any important degree of control. In the past two years, the percentage of mortality from parasitic attack has not increased, and there is no reason to anticipate that it will increase in the future if *Cactoblastis* were ever to be rendered impotent, it would most probably be due to the controlling action of parasites. Hence it is essential that scientific observation and investigation should be maintained on this important question.

## 5. OTHER PROBLEMS

The re-growth situation, and the extent of parasitism, may be considered the main questions of the future, since they are pertinent to the whole of the prickly-pear area. There are, however, various other problems of a more or less sectional nature.

(i) *The Hunter River Situation.*—Although large-scale destruction of prickly-pear is being secured over the major portion of the infested area, there are certain districts where *Cactoblastis* and other prickly-pear insects have not given entirely the same favourable results. The largest of these sections is the Hunter River Valley, where the dense pear infestation occupies probably 2,000,000 to 3,000,000 acres. The Hunter River situation has been, for the past two years, the subject of a special investigation by the Board. It has been ascertained that the slower progress of *Cactoblastis* is due to a combination of climatic factors and of soil conditions affecting the greater portion of the pear in this area. Until 1931, the results of the extensive distribution of *Cactoblastis* had been disappointing, in that the insect had failed to become established generally. In the past eighteen months, however, *Cactoblastis* has made appreciable progress; areas of destruction, somewhat limited in extent, occur at various points, while a light infestation has become fairly general throughout the district. It is hoped that this progress will continue, and that eventually the Hunter River pear will be brought under control.

(ii) *Tiger-pear* (*Opuntia aurantiaca*).—This plant occurs in many places in Queensland and New South Wales. Although the total infestation is not very great, possibly not more than 25,000 acres, it is increasing rapidly, the rate of spread being much greater than that of the main pest pears. Moreover, the application of poisoning methods has not succeeded in coping with this dangerous plant which is a very serious pest in South Africa.

*Cactoblastis* will destroy the upper growth, but not the underground bulb. The recuperative powers of the plant are so great that a few months after its apparent destruction it has regained its former size. When the failure of *Cactoblastis* to control this pest had been ascertained, the Board despatched two officers to South America eighteen months ago to undertake a special investigation of the insect enemies of *O. aurantiaca* and its near allies. A strain of cochineal attacking *O. aurantiaca* has recently been received from the Argentine, where other insects are being studied, with the view to their early introduction into Australia.

(iii) *Tree-pears.*—Extensive areas of tree-pears, *Opuntia tomentosa,* and *O. streptacantha,* more particularly the former, occur in Central Queensland. In the case of *O. streptacantha,* a special strain of cochineal from Mexico is succeeding in destroying the young plants, and is causing damage to the large plants.

As regards *O. tomentosa, Cactoblastis* will destroy the young plants, but will not attack the larger plants. The control of the seedling plants would seem assured while *Cactoblastis* is present on *O. stricta* and *O. inermis* in the same district, since there is always a suitable food supply for the caterpillars, and the resulting moths will deposit eggs on any young *O. tomentosa* plants that may arise. Hence, the spread of tree-pear is prevented, and the large plants must gradually die of old age. But, in the event of the *O. stricta* and *O. inermis* infestation being eradicated, the control of young tree-pear may cease, and it may become necessary to take further steps toward the introduction of particular insect enemies of this plant.

# GRASSES AND MAN*

Human life has been and is more dependent upon grasses than upon any other group of living things.

## GEOLOGIC GRASSLAND AND PRIMITIVE MAN

The Miocene epoch is characterized by the formation of extensive grassland areas which replaced the swampy vegetation of the preceding epochs. It also presents a world-wide prevalence of the ancestors of most grass-eating (herbivorous) mammals. These animals, by contrast with their weak-toothed and short-limbed ancestors, possessed long-crowned and strong teeth adapted for grinding grass and relatively long feet adapted for running over hard and dry grassland in search of water and to escape from enemies. The abundance of grass favoured the multiplication of the herbivorous mammals. This in turn furnished an increased food supply for flesh-eating (carnivorous) animals, and, as a consequence, these also increased in number. The grasses were thus the controlling influence in the Age of Mammals.

The human importance of this fact is that primitive man was obliged to follow these animals—his almost exclusive food supply—as they wandered from grassland to grassland. Even after he domesticated certain of the mammals—the horse, ox, sheep, goat, pig and dog—he continued to be a nomad because he still had to herd these animals from one favourable grassland to another. Virtually all primitive men were characterized by this wandering life until certain of them, in various parts of the earth, observed that several of the grasses which their animals ate produced seeds which were not only edible food but were capable of remaining so for a considerable time. Man, in other words, discovered that he could store good food for himself. Thus man ceased to be dependent entirely for his food upon his animals, which in turn fed upon the pasture grasses. The cereal grasses became a direct portion of man's diet and furnished him with some nourishment which he could obtain by staying in one place.

By thus becoming a grass-eater, man changed his life from that of a nomad to that of a settler. This change was tremendously important for mankind of all times. There have not been any beginnings of civilization apart from agriculture. The earliest known agriculture was the cultivation of the cereal grasses, which resulted in the conservation of the human energy formerly wasted in roaming, in a sense of ownership, in the development of tools and appliances from various metals, in periods of leisure time during which thought, language, literature and art could make their first appearance in human life, in the beginning of settled and social life, and, in fact in the introduction of most aspects of civilization.

Every known primitive civilization was built directly upon one or another of the cereal grasses, sometimes supplemented with pasture grasses.

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* By Morris Halperin, University of California, in *The March Scientific Monthly*, 1933.

## CIVILISATION IN ASIA

In Japan, millet and rice were cultivated since primitive times.

Human life in China, in the Indian Archipelago, in the Malay Peninsula and in the Philippine Islands was dominated by rice.

The primary food of the Aryans in northern India consisted of rice. Barley and sugar cane were also used extensively. The Aryans had pasture-lands on which they grazed their animals which furnished meat and the means of transportation. Guests and gods were honoured by being seated on grass mats. To their gods they offered up roasted grain (probably barley) and cooked rice.

The Proto-Nordics were an entirely pastoral people. They were nomadic and followed grasslands in Central and Western Asia. The invasions of the Huns, Tartars and Mongols were motivated by the necessity of finding new grasslands for their animals.

In Persia wheat was the chief constituent of human diet.

In Babylonia, about 3100 B.C., land was paid for by bronze and by grain. At about 1400 B.C., there was an appliance for ploughing the land and sowing the seed of grain in the same operation. In 450 B.C., the Historian Herodotus wrote; "the soil is peculiarly adapted to grain; no fruit trees are grown; only barley, wheat and millet are grown."

In the palace of the King of Iberia stood gold and silver vessels filled with barley juice.

The Hebrew patriarchs were shepherds of animals on grasslands. Joseph in his first dream, saw "sheaves of grain." Moses promised the Hebrews that "He (God) will put grass in your fields for your cattle." Nearly all of the religious sacrifices included a grass eating animal or grain of the cereal grasses. The story of Ruth is built around barley and wheat. There are numerous other references to grasses in the Bible.

## CIVILISATION IN AFRICA

In Egypt, wheat and barley were cultivated by 4000 B.C. In the Egyptian "Book of the Dead," King Osiris states: "I am Osiris. I live as Grain. I grow as Grain. I am Barley." The Pharaoh of Joseph's time, in his first dream, saw seven fat cows grazing in the meadow grass, and his second dream pertained to "seven ripe and seven thin ears of grain" (probably barley).

In other parts of Africa, civilization was based on another group of grasses, the sorghums. Barley and millet were also important articles of food.

## CIVILISATION IN EUROPE

In what is now Switzerland and northern Italy, the chief crops cultivated by the Lake-dwellers were barley, wheat and millet. Wheat was cultivated in Hungary during the Stone Age. The Macedonians when invading Asia became familiar with the cereal grasses grown there and introduced them into their own country as food-crops.

In Rome the first known reaper was invented in connection with the harvest of grain. Polenta, a porridge made from barley, was fed to gladiators who were called *hordeari* from *hordeum*, the Latin name for barley. The word "cereal" is from the Latin "*cerealia*" which were grain festivals in honour of the goddess Ceres.

The Lithuanians, Germans, Celts, Gauls, Illyrians, Thracians (in modern Hungary) and Numantians (in modern Spain) ate millet, barley and wheat, and drank beverages made from these grains.

## CIVILISATION IN AMERICA

The physical, social and religious life of the Mayas, Aztecs, Incas, Guatemalans, Peruvians and other American peoples was based on maize or Indian corn.

The early settlers in America brought with them from Europe seed of rye, wheat, oats and barley, and planted these for crops as early as 1625.

## OTHER ASPECTS OF CIVILISATION

The calendar came into existence as a matter of necessity connected with cereal agriculture. Nomadic life required no calendar; the natural division of time into day and night was sufficient. But the cultivation of the cereals, to be successful, required a calendar according to which planting and other agricultural operations could be performed at the time found by previous experience to be best. In the earliest Babylonian calendar, the names of eight of the twelve months of the year refer to grain. In the Egyptian calendar, certain of the names of the months also refer to cereals "Sprouting of the Grain", "Making and Watering Barley," "Ripe Grain," and "Lady of the Granary."

The earliest problems in various branches of arithmetic concerned grasses—their agriculture, their conversion into flour and loaves of bread, and their distribution to the labourers. Some of the beginnings of geometry were likewise related to grasses—the measurement of the areas of grain fields and the consideration of various forms—cylinder, rectangle, or parallelopiped—as the most economical shape for granaries. What was probably the very beginning of astronomy was the institution of observing the moon as a basis for performing the steps in the cultivation of the cereal grasses at certain times. (Many people, even in civilized countries in this century, plant seeds of crops according to the moon.)

There were a few plants other than grasses which were cultivated before historic times, e.g., the soybean, datepalm, hemp, flax, peach, apricot and grapevine. In no case, however, was any civilization dependent upon any of these plants, whereas every known civilization has been made possible and necessary by the cultivation of one or another of the cereal grasses.

## CHARACTERISTICS OF THE GRASSES

The grasses are apparently ideal pasture-plants because, instead of growing as other plants do, at the tips of the leaves which are eaten off by the grazing animal, grasses grow at the joints, the lowermost of which are generally inaccessible to the animal's mouth and are therefore uninterrupted in their growth. This explains, too, the ability of lawn grasses to continue providing a turf in spite of frequent cutting.

As food for man, a cereal grass produces each year a large yield of edible, storable and transportable food, containing a great deal of nutriment for its volume. The grasses, in addition, grow in a greater variety of conditions of climate and of soil than do any other large plants. Grasses are the chief plants which possess all the characteristics in the right proportion for constituting man's basic food.

## USES OF GRASSES

### *Food*

Bread is still the "staff of life." Breadstuffs, furnishing the sole or chief food of most of mankind, are made from grasses.

As for meat, it is true almost literally that "all flesh is grass." Animals feeding on grasses furnished beef, mutton, pork and poultry, and such by-products as milk, cream, butter, cheese, oil, eggs, wool and leather.

Most of the world's supply of sugar is made from the grass, sugar-cane. Molasses is made from sugar-cane and sorghum. Beers and similar beverages are made by fermenting the seeds of grasses—maize, barley, rice, bamboo, millet and others.

Grasses, in the form generally consumed by man, are deficient in both minerals and vitamins and must be supplemented, if growth and health are desired, by fruits and vegetables.

## BUILDING MATERIAL AND LAND RECLAMATION

Where the bamboos grow, they constitute the material out of which houses, furniture and scores of other construction objects are built. Grasses are used in the tropics to build huts and tree-houses.

For the reclamation of useless or troublesome types of land, grasses are the leading plants. Beach grass is the pioneer for reclaiming sand-dunes in the temperate regions of the world. Cord ("Rice") grass (*Spartine* spp.) is the prime plant used to reclaim mud-flats and tidal estuaries. Both of these plants are used notably in North America and in Europe. For reclaiming alkali lands for agricultural utilization, several grasses are the best adapted plants known.

## GRASSES IN THE LANDSCAPE

Grass lawns render houses and other buildings attractive. Parks owe much of their beauty and probably all of their utility to grass. Golf courses and athletic fields are grass turfs. Some grasses are used as ornamental plants in gardens, e.g., bamboo, pampas grass, zebra grass, quaking grass and "gardener's garters."

## MISCELLANEOUS USES

A small portion of the world's supply of paper comes from grasses. "Straw" hats are made from the stalks of various grasses. Whisk-brooms and sweeping-brooms are manufactured exclusively from a grass known as broom corn. The standard feed for birds is the seed of canary grass. Fishing-rods, and the vaulting poles used in Olympic games, are the stems of bamboo.

Corn stalks yield furfural, which is used as a solvent in resins and lacquers, and as a preservative in veterinary embalming material. Cornstarch is used in the stiffening and finishing of textiles, as a finisher and filler in the manufacture of writing-paper, as a stiffener in laundry work, and as a constituent of baking-powder, pies, puddings, soap, paints, adhesive substances and asbestos products.

The bamboos furnish cooking and other domestic utensils, musical instruments, hats, smoking-pipes, clothing and literally hundreds of other every-day needs of millions of people living in the tropics.

The grasses cause more hay fever than probably any other group of plants. Although constituting one of the largest families of plants, the grasses contain hardly any poisonous representatives, only the stunted or second growth of the sorghums being poisonous to animals.

## EXTENT OF GRASSLANDS

Grassland is the prime form of vegetation on the great plains and prairies of North America, on the savannahs and pampas of South America, on the veldt covering immense areas of Africa, on the enormous steppes of Russia, Siberia, China and Manchuria, on the grasslands of Australia and New Zealand, and on the lesser grassland areas distributed elsewhere on the earth's surface.

Much land is covered with cultivated grasses. For example, Indian corn is grown in the United States on over 100,000,000 acres, a greater area than that of California. Similarly, rice, wheat, barley, millet, oats, sorghum, sugar-cane, bamboos and pasture grasses cover very large areas of the earth's surface. In all probability, grasses occupy a greater portion of the dry surface of the earth than all artificial and other natural formations combined.

Grasses grow in the Arctic regions, where they constitute approximately one fourth of all the flowering plants and are more numerous than any other single family of large plants. Grasses grow, by contrast, in the hottest portions of the tropics. They are found at sea-level and on the highest mountains, in the open and in shade, on plains and on hillsides, in water and in sand, in forests and in deserts, on alkali soils and on acidic soils. In fact, grasses are found, often to a dominant extent, in any environmental condition in which plants can grow.

The family of grasses contains a larger number of individuals than all other families of large plants combined.

## VALUE OF GRASSES

The most valuable crops in the world are grasses—the cereals, sugar-cane, bamboo and hay. Statistics do not include the grass on ranges and pastures which is consumed directly by animals without going into commerce, where its value can be recorded. In the United States, maize, hay, wheat, barley, oats and rye have an annual worth of about six Billion dollars.

## SUMMARY

The geologic Age of Mammals was, in large measure, made possible by the formation of grasslands.

The almost exclusive food supply of primitive man was the meat of the animals which lived upon grass or which preyed upon grass-eating animals. Early man was a nomad, following these animals from one grassland to another.

Every known civilization had its beginning in the cultivation of one or another of the cereal grasses.

At present, grasses furnish all the bread-stuffs and most of the meat and sugar consumed by man. They also supply housing material for millions of people in the tropics.

Grasses are adapted for growth in a greater diversity of environmental condition than are any other large plants. Probably the greatest portion of the earth's dry-land surface is covered by grasses.

In general, human existence and civilization have thus far been very closely related to the natural and agricultural importance of grasses.

# REVIEWS

## SOILS: THEIR ORIGIN, CONSTITUTION, AND CLASSIFICATION

[*Soils: Their Origin, Constitution, and Classification.* An Introduction to Pedology. By G. W. Robinson. (Thos. Murby & Co.) Price, 20/-s].

THIS book, the first by the author, is a welcome addition to the few books in English on pedology, as the study of the soil from the standpoint and by the methods of pure science is designated. The aim of the writer is to give within the compass of a book of moderate size a general view of the subject, and it will generally be admitted that he has succeeded remarkably well in achieving it. With the rapid and wide-spread increase of our knowledge of soil science in all its ramifications during the last few decades, it has become increasingly difficult for soil workers to keep themselves abreast of their subject. Prof. Robinson's book, supplying as it does even the most recent, authoritative information on pedology, will be a great boon alike to the ordinary student and research worker on the subject. But the author hopes that the book "though written primarily for those who are interested in the soil as an object of study in itself, and for those whose interest lies in its economic or geographical significance", will prove of value to botanists and geologists as well.

The work is divided into three sections. The first deals with the origin, constitution and properties of soils. In these chapters great stress is placed on the importance of the soil profile, which the author very rightly considers should be the unit of study in all future pedogenic work. To use his own words: "We now know that an adequate conception of the soil can only be obtained from a study of all the horizons down to the parent material." In order to secure this end, he states "the pedologist must go into the field and study his material under natural conditions." This should give the quietus to the commonly-held view that the research worker on soils can solve in the laboratory the problems of the practical man, from the mere examination of a sample of soil taken from the first foot or two of a field. The inclusion of a discussion on soil erosion in the chapter on 'The Pedogenic Processes' is an indication of the realisation of the seriousness of the problem in many parts of the world, especially the tropics.

The next section is devoted to a description of the chief soil groups of the world, a discussion of the problem of classification and a general account of the geographical distribution of soils. It is in regard to the two former aspects of the subject that the book is so very much in advance of its predecessors, and no reader can fail to be impressed with the vast fund of valuable information presented in these chapters. Those sections on tropical soils should be of special interest to workers in these regions.

The remaining section consists of chapters on soil surveys and soil analysis, and concludes with a brief discussion on the inter-relationships of soil conditions, plant growth and agriculture. The appendix contains descriptions of the principal routine determinations necessary for the characterisation of soils.

The book is well got up and fairly well illustrated. At the end of each chapter is a useful bibliography on the subject matter covered in it. An index of places and a comprehensive subject index are also included. The book should be deservedly popular in the scientific circles for which it has been intended.—A.W.R.J.

## IMPERIAL CO-OPERATION FOR AGRICULTURE
## WORK OF EMPIRE BUREAUX

"THE Bureaux offer an outstanding example of national economy secured through co-operation in finance", states the third annual report of the Executive Council of the Imperial Agricultural Bureaux published by H. M. Stationery Office (1/- net.). From the experience which has been gained in the three years during which the Bureaux have been in existence the Council believes that the services which they are called to perform are in modern conditions indispensable to the effective conduct of research into agricultural and veterinary problems.

There are eight bureaux, financed by the British Government, the Dominions and the Colonies. They are controlled by the Executive Council which is composed of representatives appointed by the Governments of the Empire. The Government of the Bahamas, which in the first instance had only agreed to support the bureaux for one year, rejoined after one year's absence, an acknowledgment in itself of the value of the work being pursued by those bodies.

The bureaux have been established in response to a definite need felt by research workers in agricultural science for the collection, collation and dissemination of information on research being carried out in different parts of the world, as well as to fulfil a desire for contact between the workers themselves in different parts of the Empire. These contacts between bureaux and research workers show a striking general development during the year under review.

The outstanding feature of the Report, however, is that it marks for the first time the regular issue of journals from practically all the bureaux. These journals embody information abstracted from scientific periodicals in almost every language and from almost every country. *Horticultural Abstracts*, issued by the Bureau of Fruit Production and East Malling, has received the following tribute from the U.S.A.: "Horticultural Abstracts is too good for me not to have it regularly on my desk instead of having to go to the Library every time I want to refer to it. The question now is: what will it cost, and how can I secure it. If you send me this information it is possible that I can place three or four orders".

The other Journals issued are *the Veterinary Bulletin*, monthly from Weybridge, *List of Publications Relating to Soils and Fertilisers*, monthly from Rothamsted, *Plant Breeding Abstracts*, quarterly from Cambridge, *Herbage Abstracts*, quarterly from Aberystwyth, *Bulletin on Animal Genetics*, quarterly from Edinburgh, *Abstracts on Agricultural Parasitology* p epared by the Bureau at St. Alban's appear in the *Quarterly Journal of Helminthology*, whilst the journal issued from Aberdeen—*Nutrition Abstracts*

*and Reviews* — reveals co-operation between the General Medical Research Council of the United Kingdom, the Trustees of the Reid Library and the Executive Council of the Imperial Agricultural Bureaux.

The analysis of the year's expenditure bears testimony to the large part played by these Journals in the work of the Bureaux. Over 90 per cent. of the gross expenditure has been incurred in the examination, abstraction and distribution of scientific information, and in the purchase of necessary scientific books and periodicals. This expenditure also covers the issue of special bibliographies on particular subjects together with a review summarising the main points in those literature catalogues.

The advantages to any research worker of receiving information of the developments taking place in his own subject throughout the world, as well as having a ready made bibliography need scarcely be emphasised. Beyond that, the agricultural scientist has the benefit of a list of those working in his field with whom he is at liberty to communicate. He can also apply for the translation of foreign articles. During the year translations have been supplied by the Bureaux of papers issued in most European languages (including Russian, Scandinavian, Hungarian and Polish) and of a few in Japanese.

A perusal of this report can leave no doubt as to the service rendered by the Imperial Agricultural Bureaux through co-operation between the Dominions, India, the Colonies and the home country, to those engaged in research into agricultural and veterinary problems throughout the Empire.

# MEETINGS, CONFERENCES, ETC.

## THE RUBBER RESEARCH SCHEME (CEYLON)

Minutes of the thirteenth meeting of the Board of Management, held at 11 a.m. on Thursday, March 23, 1933, in Room No. 202, New Secretariat, Colombo.

*Present.*—Dr. W. Youngman (in the chair), Messrs. C. W. Bickmore, C.C.S., (Acting Financial Secretary), I. L. Cameron, C. E. A. Dias, J.P., A. E. de Silva, B. F. de Silva, H. R. Freeman, M.S.C., F. H. Griffith, J. L. Kotelawala, M.S.C., F. A. Obeyesekere, M.S.C., C. A. Pereira, B. M. Selwyn, G. K. Stewart, M.S.C., and E. W. Whitelaw.

Mr. T. E. H. O'Brien, Director of Research, was present by invitation and acted as Secretary to the meeting.

Apology for absence was received from Mr. E. C. Villiers, M.S.C., and Colonel T. Y. Wright.

### MINUTES

Minutes of the meeting held on February 16, 1933, were confirmed and signed by the Chairman.

### BOARD

The resignation of Mr. James P. Fernando was reported.

### STAFF

It was decided that Mr. R. K. S. Murray, Mycologist to the Scheme, be asked to undertake duties as Botanist in addition to mycological work.

### ACCOUNTS

(a) The following items of expenditure in excess of estimates for 1932 were sanctioned:

General Charges Rs. 316·49.

London Advisory Committee Rs. 590·37. It was noted that Rs. 589·72 represents payments to Sundry Creditors in respect of 1931.

Depreciation of buildings and equipment in Ceylon and London Rs. 5,895·12.

Certain small items in excess of detailed estimates of the Experiment Station for 1932 were also sanctioned.

(b) *Accounts and Balance Sheet for 1932.*—The statement of income and expenditure and balance sheet for 1932 were considered. Income for the year amounted to Rs. 149,266 and expenditure on revenue account to

Rs. 82,232. Expenditure on capital account amounted to Rs. 8,662. Cash in hand at December 31, amounted to Rs. 219,904 of which Rs. 216,577 represents the available balance to be carried forward.

After discussion in which it was pointed out that the surplus account was greater than the actual cash balance owing to part of the surplus being invested in buildings etc., the accounts and balance sheet for 1932 were adopted.

(c) *Auditor General's Report.*—The report on the accounts and balance sheet for 1932 was adopted after a short discussion on points which had been raised in regard to depreciation of London plant etc.

## ANNUAL REPORT FOR 1932

After discussion and slight amendment the report was adopted. It was stated that the report of the London Advisory Committee for Rubber Research (Ceylon and Malaya) had been delayed owing to illness of the staff and would be submitted later.

It was decided to have the report printed in the same style as reports issued prior to 1931 and to enquire from the Hon'ble the Minister for Agriculture and Lands whether he wished to have extra copies printed for issue as a Sessional paper.

## DEVELOPMENT OF THE RESEARCH SCHEME

The report of the Committee which had been appointed to inspect three estates in the Kalutara district was considered together with offers from the proprietors of the estates. A full discussion took place regarding the merits of the estates, the price which should be paid for planted land under present conditions, and the area of Crown land which would be required for future development. On the proposal of Mr. B. M. Selwyn seconded by Mr. G. K. Stewart it was decided to make a firm offer for one of the estates at a price proposed by Mr. Freeman and seconded by Mr. Griffith.

## TECHNICAL OFFICERS' REPORTS

The following reports were tabled:

"Further yield records in connection with *Oidium Heveae.*"

"Diseases of rubber in Ceylon 1932."

Consideration of other items on the agenda was deferred until next meeting.

Plate VII. Citrus Mildew

# DEPARTMENTAL NOTES

## CITRUS MILDEW

MALCOLM PARK, A.R.C.S.,

*GOVERNMENT MYCOLOGIST*

POWDERY mildew is very common on orange leaves in the wetter areas of Ceylon and in India and Java. It has recently been introduced into California but has not yet been recorded from other citrus growing countries.

In Ceylon, it is most common on orange types, i.e., the sweet orange, the Ceylon sour orange and the mandarin orange. It also attacks grape fruit, pummelo, lemon and *Kalamondin* but it has not been found to attack limes.

### SYMPTOMS OF THE DISEASE

Powdery mildew is readily noticeable and easily identified. Young, actively growing leaves and succulent shoots are most commonly affected, and usually the young shoots near the centre of the tree show the disease. Suckers which are allowed to run from the base up into the centre of the trees are very often attacked.

The first appearance of the disease on the young leaves generally occurs on the edges, as small isolated spots, when the fungus can be distinguished as fine radiating lines. Given suitable conditions, such as moist damp weather, the fungus growth increases rapidly until parts, and sometimes all, of the succulent young shoots become covered with the white, powdery or felted mildew. It is when the fungus is in this condition that the disease is most commonly noticed and most growers of orange trees are doubtless familiar with shoots of the type illustrated. There is a darkening and usually a definite depression of the diseased leaf surface, often followed in severe attack by a general buckling of the whole leaf. In the older stages some of the green colouring matter may disappear from the leaf and the affected leaves are consequently often decidedly yellowish in colour.

The youngest leaves become shrivelled when they are attacked and often fall off, leaving the bare green twig. The twig dies back and the young growth of orange trees is sometimes completely destroyed in this way. More commonly, however, some of the larger leaves remain on the shoot but their irregularly buckled and distorted appearance, which persists when they grow older, serves to show that they were attacked when young, even though the fungus can no longer be easily distinguished.

Leaves which survive the attack may have parts of their surface killed and these dead areas provide a means of entrance of fungi causing further diseases which may prove to be detrimental to the health of the tree.

## THE CAUSE OF THE DISEASE

The disease is caused by the fungus *Oidium tingitatinum* which can be seen with the naked eye as the white powdery layer of mildew on the surface of newly attacked leaves. The fungus is almost entirely superficial and feeds on the plants by means of minute suckers or haustoria which penetrate into and kill the cells of the tissue on which the fungus is growing. The powdery appearance of the mildew is due to the presence of innumerable minute seeds or spores of the fungus. These may be carried by the wind or rain-splashes to the healthy leaves where they may grow to start fresh centres of infection.

The fungus is most active in warm, damp weather; such weather usually occurs at the times when the trees put out their new shoots.

## CONTROL OF THE DISEASE

The fungus, as stated above, lives almost entirely on the surface of the shoots and for that reason is more amenable to direct control measures than most other fungi causing diseases. It has been shown that the disease can easily be checked and the fungus killed by spraying or dusting with a fungicide, especially with a fungicide containing sulphur. Not only can the disease be checked in this way but healthy young leaves can be protected from the disease by spraying.

In most districts in Ceylon, there are regular periods in which citrus trees put out new shoots; such periods vary in different districts. If the trees are watched and two or three sprayings with a fungicide containing sulphur are applied during growing periods complete control of the disease can be assured. Details of the preparation and method of application of a cheap and efficient fungicide can be obtained from any Agricultural Instructor or from the writer.

Trees on which the disease have been destructive in the past should be cleaned up by pruning out dead and dying shoots and branches. As a general rule, young suckers should not be allowed to grow up from the bottom of the tree and should be pruned out. Severely affected shoots may be removed and burned since they will not develop normally.

# RECENT PROGRESS IN TURMERIC CULTIVATION*

W. MOLEGODE.

*AGRICULTURAL INSTRUCTOR, KATUGASTOTA*

DURING the last two years special attention has been devoted to encourage and stimulate more extensive cultivation of turmeric in village holdings, having in view the possibility of Ceylon being able to grow sufficient quantities to replace gradually with home grown turmeric some of the six hundred tons of turmeric now being imported per year. The results so far have been very encouraging and may even be said to be beyond expectations. This season there are over a thousand plots of turmeric, each ranging from a small plot of 1/100th of an acre to 1 acre scattered all over the Kandy district. In Harispattu division alone there are 450 growers. In addition to these, it is known that turmeric cultivation has been taken up in other districts. Kotmale in Nuwara Eliya district may be specially mentioned as a centre where turmeric is likely to be grown on an appreciable scale.

Turmeric is a condiment needed, though in small quantities, every day in our homes, and is a crop which can easily be cultivated, but until recently few, apparently, thought of growing turmeric for sale or for their own needs. In most village gardens turmeric is to be found growing and when required is employed for medicinal and ceremonial purposes. Small quantities of not too well prepared turmeric were available in some villages during the season. In 1932 the question of curing a marketable commodity was taken up. Trials conducted showed that a commodity as good as the best imported turmeric could be turned out with locally grown turmeric. Samples prepared at Katugastota were reported on very favourably by Colombo dealers and were valued at the same prices as the imported stuff. Small local traders did not hesitate to buy any quantity at the prices paid for imported turmeric.

These trials were followed by demonstrations of the methods of curing given to a number of growers in the Katugastota area. Fair quantities of village cured turmeric, typical of what used to be hitherto turned out, were also improved and shown. The possibilities were at once realised and this year larger quantities of locally cured turmeric were available at the weekly fairs, village kaddies and bazaars.

From January this year the turmeric planted last year began to be lifted and it was clear, judging from the amount of turmeric harvested and cured at various centres that more planting was done in 1932 than before. Growers who attended the demonstrations and received instruction were able to cure this season's turmeric for the markets. A further series of demonstrations, in addition to those held within the Katugastota range, were specially arranged and given at the following places: Mirigama Show, Kotmale and Siyambalagoda.

* See also "Turmeric, Its Cultivation and Preparation in the Kandy District"—*The Tropical Agriculturist*, LXXIX, No. 5, November 1932, pp. 271-273.

In December 1932, a Turmeric Growers' Union was formed at Katugastota with three main objects, (1) to encourage wide-spread cultivation of turmeric; (2) to act as an Information Bureau; and (3) to undertake, if necessary, co-operative curing. A turmeric cultivation competition in Harispattu was organised, and largely due to the interest taken by the Ratemahatmaya, 393 competitors have entered the competition this year. Small quantities of seed turmeric have been supplied among 160 growers. A number of villagers have received a thorough training on curing methods and are now competent to undertake curing of turmeric on a large scale.

At Giragama, an area adjoining the ginger trials has been planted with seed turmeric imported from Cochin States as well as a small area with Ceylon turmeric to serve as a seed supply station. Areas in Katugastota and Dunuwille, also to serve as seed supply stations, have been established. Ample provision has, therefore, been made to meet any demand for seed turmeric.

Full information on cultivation of turmeric and methods of curing are now available in various publications of the Department.

# ANIMAL DISEASE RETURN FOR THE MONTH ENDED 30 APRIL 1933

| Province, &c. | Disease | No. of Cases up to Date since Jan. 1st 1933 | Fresh Cases | Recoveries | Deaths | Balance Ill | No. Shot |
|---|---|---|---|---|---|---|---|
| Western | Rinderpest | ... | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | 22 | ... | 21 | 1 | ... | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| | Rabies (Dogs) | 11 | 1 | ... | 10 | ... | 1 |
| | Piroplasmosis | ... | ... | ... | ... | ... | ... |
| Colombo Municipality | Rinderpest | ... | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | 28 | ... | 27 | 1 | ... | ... |
| | Anthrax | 3 | ... | ... | 3 | ... | ... |
| | Rabies (Dogs) | 15 | 2 | ... | ... | ... | 15 |
| | Haemorrhagic Septicaemia | ... | ... | ... | ... | ... | ... |
| | Black Quarter | ... | ... | ... | ... | ... | ... |
| | Bovine Tuberculosis | ... | ... | ... | ... | ... | ... |
| Cattle Quarantine Station | Rinderpest | ... | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease (Sheep & Goats) | 92 | 22 | 87 | 5 | ... | ... |
| | Anthrax (Sheep & Goats) | 66 | 2 | ... | 66 | ... | ... |
| Central | Rinderpest | 65 | 31 | 4 | 51 | 8 | 2 |
| | Foot-and-mouth disease | 3 | ... | 3 | ... | ... | ... |
| | Anthrax | 10 | 1 | ... | 10 | ... | ... |
| | Black Quarter | ... | ... | ... | ... | ... | ... |
| | Rabies (Dogs) | ... | ... | ... | ... | ... | ... |
| Southern | Rinderpest | ... | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | 50 | ... | 50 | ... | ... | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| | Rabies (Dogs) | 1 | 1 | ... | ... | ... | 1 |
| Northern | Rinderpest | 451 | 328 | 50 | 370 | 14 | 17 |
| | Foot-and-mouth disease | 4 | .. | 4 | ... | ... | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| | Black Quarter | ... | ... | ... | ... | ... | ... |
| | Rabies (Dogs) | ... | ... | ... | ... | ... | ... |
| Eastern | Rinderpest | ... | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | 52 | ... | 51 | 1 | ... | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| North-Western | Rinderpest | ... | ... | ... | ... | .. | ... |
| | Foot-and-mouth disease | 3 | ... | 3 | ... | ... | ... |
| | Anthrax | ... | ... | .. | ... | ... | ... |
| | Pleuro-Pneumonia (Goats) | 3 | ... | ... | 1 | ... | 2 |
| | Rabies (Dogs) | 1 | ... | ... | ... | ... | 1 |
| North-Central | Rinderpest | 844 | 160 | 135 | 657 | 34 | 18 |
| | Foot-and-mouth disease | ... | ... | ... | ... | ... | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| Uva | Rinderpest | ... | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | ... | ... | ... | ... | ... | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| | Bovine Tuberculosis | 2 | 2 | ... | ... | ... | 2 |
| Sabaragamuwa | Rinderpest | ... | ... | ... | ... | ... | ... |
| | Foot-and-mouth disease | ... | ... | ... | ... | ... | ... |
| | Anthrax | ... | ... | ... | ... | ... | ... |
| | Piroplasmosis | ... | ... | ... | ... | ... | ... |
| | Haemorrhagic Septicaemia | 3 | ... | ... | 3 | ... | ... |
| | Rabies (Dogs) | ... | ... | ... | ... | ... | ... |

G. V. S. Office,
Colombo, 11th May, 1933.

M. CRAWFORD,
Govt. Veterinary Surgeon.

# METEOROLOGICAL REPORT

## APRIL, 1933

| Station | Temperature | | | | Humidity | | Amount of Cloud | Rainfall | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean Maximum | Difference from Average | Mean Minimum | Difference from Average | Day | Night (from Minimum) | | Amount | No. of Rainy Days | Difference from Average |
| | ° | ° | ° | ° | % | % | | Inches | | Inches |
| Colombo | 88·0 | +0·2 | 76·0 | +0·3 | 72 | 91 | 6·6 | 3·25 | 13 | − 5·74 |
| Puttalam | 89·3 | +0·3 | 75·7 | −0·1 | 74 | 93 | 4·6 | 4·22 | 8 | − 1·25 |
| Mannar | 90·7 | −1·0 | 77·5 | −0·2 | 72 | 89 | 5·4 | 0·70 | 4 | − 2·18 |
| Jaffna | 89·8 | +0·6 | 78·7 | −1·0 | 80 | 91 | 4·4 | 1·29 | 5 | − 0·79 |
| Trincomalee | 87·9 | −0·8 | 77·3 | −0·1 | 74 | 89 | 3·8 | 4·27 | 8 | + 2·17 |
| Batticaloa | 87·2 | −0·6 | 76·7 | +0·4 | 72 | 91 | 3·5 | 4·28 | 5 | + 2·36 |
| Hambantota | 88·0 | +0·8 | 76·2 | +0·5 | 74 | 88 | 3·8 | 1·90 | 6 | − 1·60 |
| Galle | 86·2 | −0·3 | 76·9 | +0·6 | 77 | 88 | 5·4 | 10·17 | 14 | + 0·46 |
| Ratnapura | 91·2 | 0 | 73·9 | +0·1 | 73 | 93 | 6·2 | 16·68 | 19 | + 4·31 |
| A'pura | 91·6 | +0·2 | 74·7 | −0·1 | 68 | 90 | 5·8 | 5·12 | 11 | − 1·75 |
| Kurunegala | 91·4 | −0·3 | 74·7 | 0 | 68 | 93 | 6·4 | 9·88 | 10 | − 0·14 |
| Kandy | 87·8 | +0·3 | 69·6 | −0·3 | 68 | 92 | 4·6 | 3·55 | 9 | − 3·26 |
| Badulla | 84·2 | +0·4 | 66·6 | +0·4 | 72 | 97 | 5·0 | 5·39 | 14 | − 2·08 |
| Diyatalawa | 78·0 | +0·6 | 60·9 | +0·9 | 70 | 91 | 6·0 | 5·53 | 17 | − 0·63 |
| Hakgala | 73·6 | −0·7 | 54·6 | −0·2 | 76 | 94 | 5·4 | 5·62 | 14 | − 1·65 |
| N'Eliya | 71·8 | +0·8 | 49·0 | −0·3 | 73 | 96 | 5·5 | 5·54 | 16 | − 0·13 |

Thunderstorm activity was fairly well in evidence in April but the accompanying rain was below, rather than above, average over the greater part of the Island. Excesses and deficits of rainfall were somewhat irregularly distributed, but, on the whole, deficits predominated in the north and west of the Island and the central hill country, while excesses were the rule in the south and east.

The highest totals for the month were 22·46 inches at Carney, 21·34 at Keragala, 20·75 at Beausejour and 20·50 at Digalla, while about a dozen stations, early all in the south-west of the Island, recorded between 15 and 20 inc for the month. All stations reported some rain and only about a score of stations, chiefly in the north and north-west, recorded under 2 inches during the month.

There were 17 falls of over 5 inches in a day, the largest being 7·23 inches at Wariapolla and 7·13 inches at Morawaka both on the 5th-6th, on which day the majority of these heavy falls occurred.

A phenomenon of particular interest during the month was the occurrence of a fall of hail at Ratnapura on the afternoon of the 26th.

Indications for the ensuing monsoon season are by no means very definite. Temperatures during February and March were not far from average and point to a normal monsoon. On the other hand, the correlation afforded by the local thunderstorm activity of March and April suggests a slightly greater monsoon rainfall than usual.

Temperatures were, on the whole, about normal.

D. T. E. DASSANAYAKE,
Actg. Supdt., Observatory.